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PHASE I & II FINAL REPORT

VOLUME III
COST ESTIMATES AND WORK BREAKDOWN STRUCTURE/DICTIONARY

SYSTEM TECHNOLOGY ANALYSIS OF AEROASSISTED ORBITAL TRANSFER VEHICLES: MODERATE LIFT/DRAG (0.75-1.5)

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GENERAL ELECTRIC

FORWARD

This final report of the "System Technology Analysis of Aeroassisted Orbital Transfer Vehicles: Moderate Lift/Drag (0.75-1.5)" was prepared by the General Electric Company, Space Systems Division for the National Aeronautics and Space Administration's George C. Marshall Space Flight Center (MSFC) in accordance with Contract NAS8-35096. The General Electric Company, Space Systems Division was supported by the Grumman Aerospace Corporation as a subcontractor during the conduct of this study. This study was conducted under the direction of the NASA Study Manager, Mr. Robert E. Austin, during the period from October 1982 through June 1985.

The first phase of this program focused on a ground based AOTV and was completed in September 1983. The second phase was directed towards a space based AOTV and the cryofueled propulsion subsystem-configuration interactions and was completed in March of 1985. The second phase was jointly sponsored by NASA-MSFC and the NASA Lewis Research Center (LeRC). Dr. Larry Cooper was the LeRC study manager.

This final report is organized into the following three documents:

Volume IA	Executive Summary - Parts I & II
Volume IB	Study Results - Parts I & II
Volume II	Supporting Research and Technology Report
Volume III	Cost and Work Breakdown Structure/ Dictionary

Part I of these volumes covers Phase 1 results, while Part II covers Phase 2 results.

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AOTV FINAL REPORT, VOLUME III

COST ESTIMATE AND WORK BREAKDOWN STRUCTURE/DICTIONARY

1.0 COSTING APPROACH, METHODOLOGY AND RATIONALE

Technology payoffs of representative ground based Mid L/D AOTVs have been assessed and prioritized in Phase I of this study. Phase II of this study was directed toward identification and prioritization of technology payoffs of representative space based Mid L/D AOTVs and the cryofueled propulsion subsystem - configuration interactions.

This volume contains a narrative summary of the cost estimates and work breakdown structure/dictionary of both Phases I and II of this study.

The costs associated with developing, building and operating new AOTVs were estimated in two different ways. Both techniques, however, extensively utilized the costing methodology and relationships that were used on Grumman's MOTV (Ref. 1) study. The MOTV costs have correlated very closely with NASA Johnson Space Center costs for manned orbit transfer vehicles. A summary of AOTV cost methodology is shown in Figure 1-1.

1.1 Work Breakdown Structure (WBS)

Figure 1-2 depicts the Work Breakdown Structure (WBS) used for the cost estimates of configuration OH-3, OH-1, 38' GEO delivery, H-1M, and OH-2M. This WBS follows the standard WBS of the joint government/industry Space Systems Cost Analysis Group (SSCAG). Each WBS item is further broken down into DDT&E, Production, and Operations. The summation of all items results in life cycle cost. A more detailed Level 5 breakdown and WBS dictionary is included in Appendix A.

1.2 Cost Model

Costs were estimated by the use of Grumman's space programs algorithm for cost estimating ("SPACE") program. This program

was developed to facilitate the calculation of life cycle costs of space systems based on a stored bank of cost estimating relationships (CER's). Some CER's were parametrically generated from available data and others collected from industry wide publications. The user must choose the most appropriate CERS, specify his WBS, and supply input data to "SPACE". In addition, the user must specify the sequence and methodology of generating wraparound costs and determine complexity factors (where these are applicable).

1.3 Cost Estimating Relationships (CER's)

The CER's in "SPACE" estimate costs on the subsystem level, some as low as level 6. The CER's used for the AOTV study were carefully picked for applicability to each subsystem and are identical to those used in our 1980 MOTV study.

1.4 Complexity Factors

As shown in the input echos (i.e., print out of input data) of Figure 1-10, four complexity factors are specified for each subsystem. The first one is a commonality factor which, is less than one, would account for cost reductions due to prior development. The second and third factors account for DDT&E complexity and production complexity, with respect to the standard of normal complexity of the data base from which the CER was developed. The fourth complexity factor increases or decreases development costs according to the subsystem being below or above the present state-of-the-art.

1.5 Program Wraparound Costs

Figure 1-3 summarizes the wraparound costing philosophy used for the AOTV. The Space Vehicle is composed of, at most, a crew module, vehicle module and drop tanks. Wraparound factors of a) 3% for System Test and Evaluation, b) 20% for installation, assembly and checkout, and c) 9% for system engineering and integration, are applied to the cost of the space vehicle. Wraparound factors of 10%, 10% and 5% are applied, respectively, to the cost of Ground Support Equipment for the crew module, vehicle module and drop tanks. The combined costs of Space Vehicle, Ground Support Equipment and Flight Support Equipment (also known as ASE) are wrapped around by 3% (for Trainers and Simulations) and 1.3% (for training). The entire AOTV Program has management wraparounds of 2% for development, 2% for production and 1% operations.

2.0 SUMMARY COST PRESENTATIONS

2.1 Ground Based AOTVs - Phase I Results

Four different AOTVs were identified during the Phase I study: OH-1, OH-3, 38' GEO Delivery, and H-1M. Contractor program costs for these vehicles are displayed on Figures 1-4, 5,

6 and 7. These costs range from $630M to $1.4 Billion (1984 $).

The most attractive ground based GEO delivery vehicle that surfaced during this study, OH-3, was examined to form an estimate of the total transport cost, from earth to GEO, for a satellite user. These costs are displayed on Figure 1-8. They do not include amortization of an AOTV, or its development costs.

Two columns of figures are presented in Figure 1-8. One is for a delivery of a single "heavy Intelsat VI" type of satellite, which has a useful weight at GEO of 6030 lb. The other column is for 3 satellites, each of which has a useful GEO weights of 4560 lb.

The OH-3 is a two stage delivery system. The satellites are their own upper stages. Their station keeping propellant tankage has been enlarged to accommodate the required apogee impulse. "Useful weight at GEO" has subtracted the added tankage weight from the satellite's GEO burnout weight.

When "total launch costs", which approximate user costs since propellant costs are trivial, are divided by "useful payload at GEO", a cost of getting a satellite to GEO is obtained in $/lb of satellite (at GEO). The two values in Figure 1-8, $9765/lb and $6890/lb, represent the most efficient costs for OH-3 using one, or two, sets of drop tanks. These two points shown up in Figure 1-9 as, respectively, the lowest point on the left portion of the curves, and as the lowest point on the right hand side of the curve.

Two observations should be made on the weight and cost value limits which are shown on Figures 1-8 and 1-9. The first is that the lowest cost to GEO, about 7000/lb is based upon the assumption that the payloads will utilize the maximum capacity of the delivery vehicle (OH-3). In general, this will not occur and the minimum point on the curve is not necessarily representative of average payload costs. The second observation is that the engineering design and analysis that led to the OH-3 configuration (and Figures 1-8 and 1-9) did not optimize loading in the orbiter cargo bay. Only 58,000 lb of the 65,000 lb cargo carrying capacity of the orbiter was used. If the full 65,000 lb were used by enlarging the OH-3 drop tanks and increasing paylaod density, approximately 16,000 useful pounds would be delivered to GEO at a cost of $6,000/lb. A prior manifesting study (Ref. 2) has indicated that STS transport of a cryo OTV, with payloads, would result in an 83% utilization of the orbiter cargo bay. Applying this factor to a maximum GEO payload of 16,000 lb produces a typical (average) OH-3 delivered weight ("useful weight at GEO") of 13,3090 lb and a typical cost to GEO of $7000/lb. By amortizing the development cost of OH-3 over 43 flights, typical costs increase $1000/lb (at 13,3090 lb). Consequently, we have used $80900/lb as a representative cost of delivering payloads to GEO using OH-3 in a ground based mode.

These cost estimates include a standard NASA launch charge (as indicated) for transport of the fueled AOTV and payload to LEO.

2.2 Space Based AOTVs - Phase II Results

The major configuration conclusions reached in Phase II of this study indicate no major advantages in departing from the general modularized STS transportable biconic AOTV configuration developed in Phase I.

Numerous additional configurations, within the Mid L/D family, were developed during Phase II. Based on the cost estimating algorithms of the "SPACE" program, no major cost estimate differences were expected, due to "Space Basing", of the AOTVs in Phase II with the exception of three items.

The first involves the cost estimate for a space based OH-2M, Figure 1-10. The major program cost difference for this evolutionary manned AOTV involves deleting the $84.1M charge for a flight test (as for H-1M), since it is assumed that in an evolutionary program, the aeromaneuvering technology has previously been established by the small, delivery only AOTV, OH-3. OH-3 due to its small size was charged only $24.3M for a flight test during the development phase.

The second difference, from the ground based program, involved the recognition that propellant transport to and storage at LEO was quite a controversial and much studied area. Results coming from the AOTV Phase A studies, conducted concurrently with this study, were unanimous regarding the propellant transport and storage costs being a large (>60%) portion of the life cycle costs. There was however a large difference of opinion regarding the magnitude of the number. For the trending analyses of this study we have used $1000/lb of propellant for a 10 year period. Ten unmanned delivery GEO flights/year were assumed in the trending analyses. The magnitude of transport costs and cost savings in the trending analysis presented in Volumes IA and IB can be readily updated by the reader to reflect his preferred version of average propellant transport cost.

The third difference, from the ground based program, involved a serious look at the real cost of propellant transport, measured in terms of how many STS launches are required over a period of time. This portion of the study examined and compared both storable and cryogenic propellants, ground and space based modes of operation, and payload manifesting, to take advantage of unique payload size differences and some payload launch schedule flexibility. This evaluation was conducted outside the framework of the costing task of this study, but as can be seen from a review of the results presented in Section 2.1.1 of Volume IA - Part II and Section 3.2.3 of Volume IB - Part II could have a significant impact relative to propellant choices and transport cost sensitivities. This area obviously requires further

evaluation.

3.0 COST ESTIMATE BY WBS ELEMENT

The results of the "SPACE" computer runs for the four AOTV configurations considered are included in Appendix B.

The input echo shows the WBS number and prescriptor followed by the CER input parameters. If two parameters are shown, the first one is used for design, development, test and evaluation (DDT&E) and the second one for the theoretical first unit (TFU) CER. The three input values refer to DDT&E, TFU, and operating costs respectively. The PFU (Per First Unit) quantity denotes the number of systems needed for the first unit and the total quantity needed for the total producton, which consists of two vehicles in this case. The ground test quantity refers to the number of equivalent ground test units needed for each WBS item, which is followed by the four complexity factors described above.

The cost output also shows the WBS numbers and descriptors followed by DDT&E, production, and operating costs, which are summed to LCC (life cycle costs) in the last column. The DDT&E costs are broken down into engineering, design, development and ground test hardware. Production costs are shown for first unit, total production, and initial spares. Operational spares are excluded from the operating costs as non-applicable to the two AOTV's considered.

REFERENCES

1. Boyland, R.E., Sherman, S.W., and Morfin, H.W., "Manned Geosynchronous Mission Requirements and Systems Analysis Study", NASA CR-160429, Grumman Aerospace Corporation, Bethpage, N.Y., November 1979.

2. Grumman Space Station Study, Spring 1983.

FIGURE 1-1 - AOTV PROGRAM COST METHODOLOGY

IDENTICAL TO MOTV STUDY (1980)

- COST ESTIMATING RELATIONSHIPS ($/LB, ETC)
- COST MODIFIERS (COMPLEXITY, STATE-OF-THE-ART, COMMONALITY)
- WEIGHT DISTRIBUTION AMONG SIMILAR SUBSYSTEMS

  AVIONICS = GN&C + PWR CONV/DIST + INSTRUMENTATION + COMM/DATA HANDLING

- ALL COSTS ESCALATED TO 1984 $

EXCEPT FOR THE FOLLOWING CHANGES:

- ENGINE DEVELOPMENT COSTS ARE EXCLUDED
- MISSION OPERATIONS REDUCED TO REFLECT
  - SINGLE STS LAUNCH VS THREE FOR MOTV
  - ABSENCE OF MANNED CAPSULE FOR DELIVERY VEHICLES.
- SUBSYSTEM WEIGHTS INCLUDE 10% CONTINGENCY

FIGURE 1-2 **WORK BREAKDOWN STRUCTURE (WBS) ORGANIZATION**

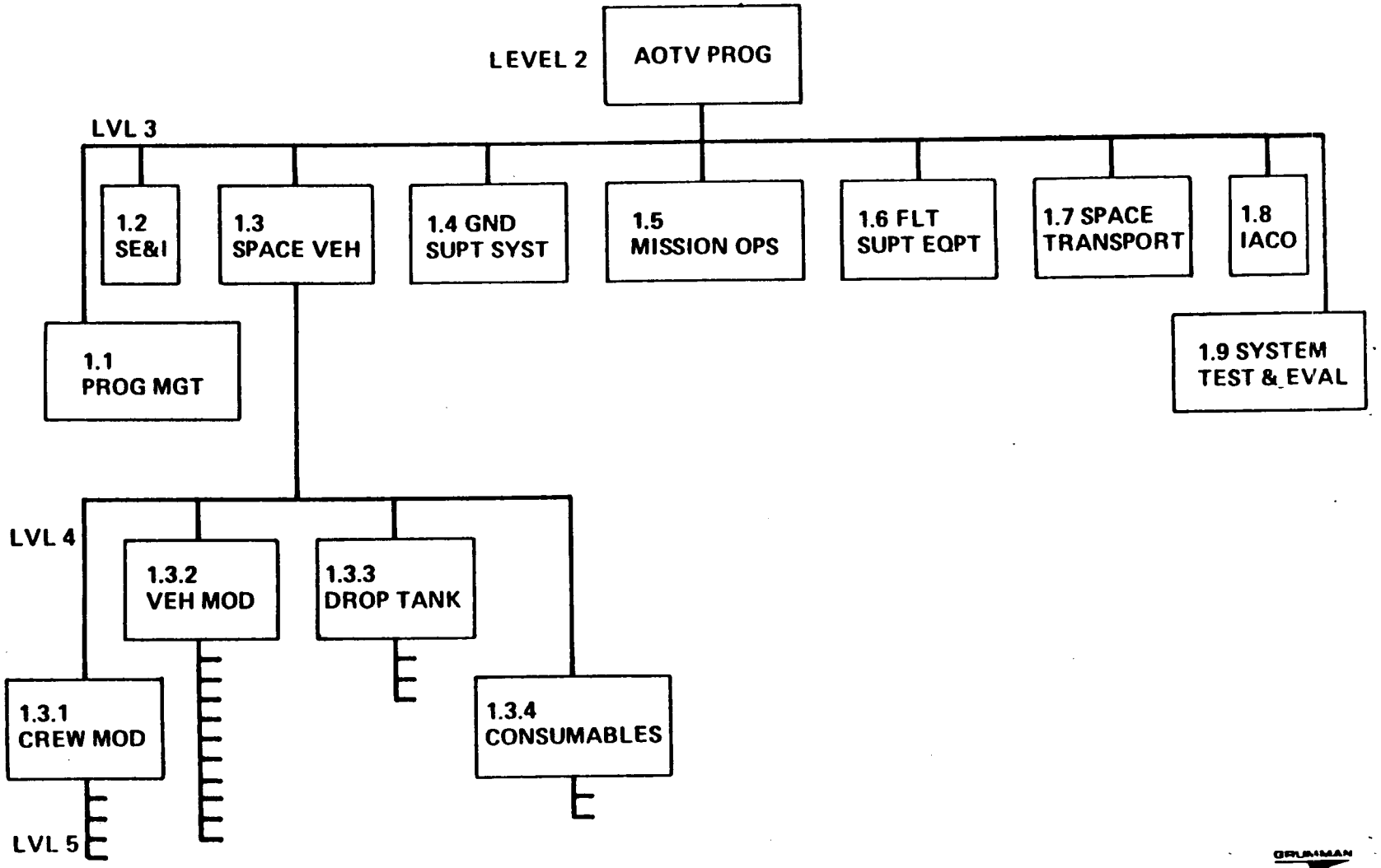
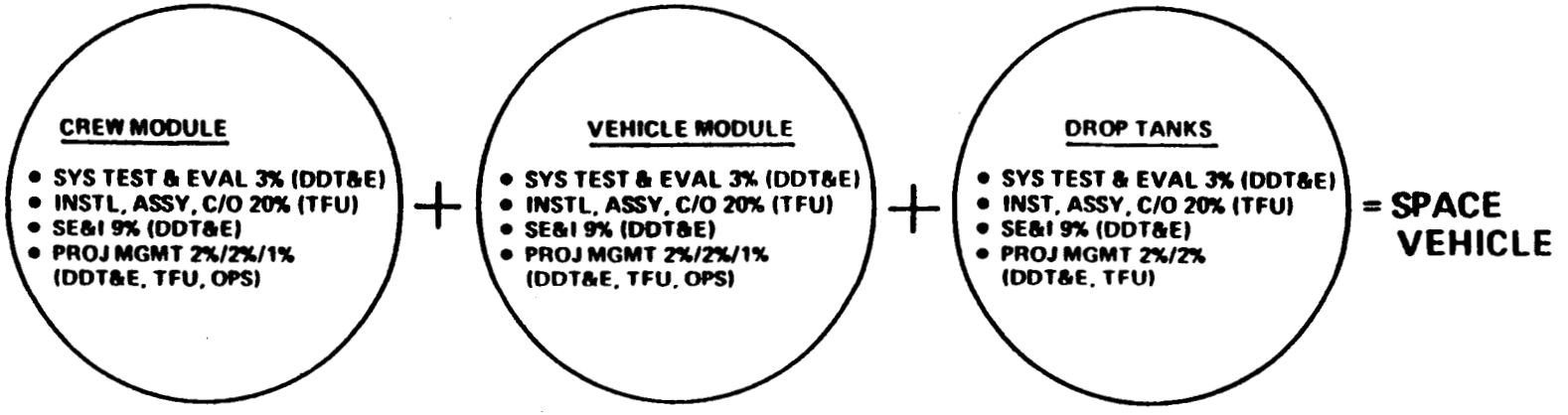


FIGURE 1-3 AOTV PROGRAM WRAPAROUND COST ALLOCATION & FACTORS



- SYS TEST & EVAL 3% (OF SPACE VEHICLE)
- INSTL, ASSY, C/O 20% (OF SPACE VEHICLE)
- SE&I 9% (OF SPACE VEHICLE)
- TRAINERS/SIM 3% (SPACE VEHICLE, GROUND SUPPORT, FLIGHT SUPPORT)
- TRAINING 1.3% (SPACE VEHICLE, GROUND SUPPORT, FLIGHT SUPPORT)
- GSE 10% /10%/5% (OF CM, VM, DT)
- PROJ MGMT 2% DEV, 2% PROD, 1% OPS

FIGURE 1-4 - CONTRACTOR PROGRAM COSTS ('84$): OH-1

- SPARES + FIRST UNIT + DDT&E = $660M

PROGRAM COSTS IN MILLIONS (1984$)

	COST ELEMENT	DDT&E	1ST UNIT	SPARES	OPS
1.1	PROJ MGMT	10.7	1.3		0.05
1.2	SYST ENG & INT	29.3			
1.3	SPACE VEHICLES	375.4	52.9	4.8	3.85
	VEHICLE MODULE	(344.3)	(49.1)	(4.0)	(0.06)
	DROP TANKS	(31.2)	(3.8)	(0.8)	(3.8)
1.4	GROUND SUPPORT	54.9			
1.5	MISSION OPS	4.4			1.6
1.6	FLT SUPPORT EQ (ASE)	77.4			
1.7	SPACE TRANSPORT*	29.1**			PAYLOAD DEPENDENT*
1.8	INSTL, ASSY, & C/O		10.4		
1.9	SYST TEST & EVAL	9.0			
	PROGRAM TOTALS	$590.2M	$64.5M	$4.8M	$5.5M+(TBD)

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**FLIGHT TEST OF SYSTEM

FIGURE 1-5 - CONTRACTOR PROGRAM COSTS ('84$): OH-3

- SPARES + FIRST UNIT + DDT&E = $630M

PROGRAM COSTS IN MILLIONS (1984$)

	COST ELEMENT	DDT&E	1ST UNIT	SPARES	OPS
1.1	PROJ MGMT	10.2	1.3		0.05
1.2	SYST ENG & INT	27.8			
1.3	SPACE VEHICLE	358.2	52.7	4.8	3.9
	VEHICLE MODULE	(327.0)	(48.9)	(4.0)	(0.06)
	DROP TANKS	(31.2)	(3.8)	(0.8)	(3.8)
1.4	GROUND SUPPORT SYS	52.5			
1.5	MISSION OPS	4.4			1.6
1.6	FLT SUPPORT EQ (ASE)	77.4			
1.7	SPACE TRANSPORT*	24.3**			PAYLOAD DEPENDENT*
1.8	INSTL, ASSY, & C/O		10.3		
1.9	SYST TEST & EVAL	8.5			
	PROGRAM TOTALS	$563.2M	$64.3M	$4.8M	$5.6M+TBD

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**FLIGHT TEST OF SYSTEM

GRUMMAN

FIGURE 1-6 CONTRACTOR PROGRAM COSTS ('84$): 38' GEO DELIVERY VEHICLE

- SPARES + FIRST UNIT + DDT&E = $650M

PROGRAM COSTS IN MILLIONS (1984 $)

COST ELEMENT	DDT&E	1ST UNIT	SPARES	OPS
1.1 PROJ MGMT	9.8	1.7		0.02
1.2 SYST ENG & INT	23.1			
1.3 SPACE VEHICLE	318.9	70.7	5.8	0.12
VEHICLE MODULE	(318.9)	(70.7)	(5.8)	(0.08)
1.4 GRND SUPPORT SYST	46.1			
1.5 MISSIONS OPS	4.4			1.6
1.6 FLT SUPPORT EQPT (ASE)	77.4			
1.7 SPACE TRANSPORT*	71. **			84.1*
1.8 INSTL, ASSY, & C/O		13.9		
1.9 SYST TEST & EVAL	7.1			
PROGRAM TOTALS	$557.7M	$86.3M	$5.8M	$85.8M

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**FLIGHT TEST OF SYSTEM

FIGURE 1-7 - CONTRACTOR PROGRAM COSTS ('84$): H-1M

- SPARES + FIRST UNIT + DDT&E = $1.38 B

PROGRAM COSTS IN MILLIONS (1984 $)

COST ELEMENT		DDT&E		1ST UNIT		SPARES	OPS
1.1 PROJ MGMT		20.5		3.8			0.1
1.2 SYST ENG & INT		58.8					
1.3 SPACE VEHICLE		796.7		159.1		13.0	1.8
CREW MODULE	(282.8)		(75.7)		(6.2)		
VEHICLE MODULE	(505.9)		(81.8)		(6.7)		
DROP TANKS	(7.9)		(1.6)		(0.1)		1.6
1.4 GRND SUPPORT SYST		104.9					
1.5 MISSIONS OPS		11.1					3.9
1.6 FLT SUPPORT EQPT (ASE)		81.4					
1.7 SPACE TRANSPORT *		84.1**					84.1*
1.8 INSTL, ASSY, & C/O				31.2			
1.9 SYST TEST & EVAL		18.0					
PROGRAM TOTALS		$1175.5M		$194.1M		$13M	$91.5M

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**FLIGHT TEST OF SYSTEM

FIGURE 1-8

OH-3 USER COSTS

	COST IN MILLIONS (1984$)			
	"HEAVY" INTELSAT		3 PAYLOADS	
MISSION OPERATIONS (1.5)*		($1.59M)		($1.8M)
PRE-LAUNCH PLANNING	0.1		0.1	
PRE-LAUNCH OPS	0.25		0.36	
MISSION PLANNING	0.2		0.3	
MISSION OPS SUPPORT	0.02		0.03	
TURNAROUND PLANNING	0.02		0.02	
TURNAROUND OPERATIONS	1.0		1.0	
DROP TANK SYSTEM (1.3.3)*		($3.78M)		($7.33M)
STRUCTURE (TANKS + DE-ORBIT + CONNECTING HARDWARE)	1.75		3.5	
INSULATION	0.13		0.26	
INTERSTAGE STRUCTURE	1.24			
INTERTANK STRUCTURE			1.47	
PAYLOAD SUPPORT STRUCTURE			0.82	
INSTL, ASSY, & C/O	0.62		1.21	
PROJECT MGMT	0.04		0.07	
VEHICLE MODULE (1,3.2)*		($0.06M)		($0.06M)
AEROSHELL SYSTEM	0.04		0.04	
INTERNAL TANKAGE	0.02		0.02	
PROJECT MANAGEMENT (1.1)*		($0.05M)		($0.05M)

*NUMBERS IN PARENTHESES CORRESPOND TO ASSOCIATED WBS ITEMS.

FIGURE 1-8 **OH-3 USER COSTS (CONTD)**

		COST IN MILLIONS (1984$)		
		"HEAVY" INTELSAT	3 PAYLOADS	
APOGEE KICK STAGE (SATELLITE)		($0.3M)		($0.9M)
ADDITIONAL TANKAGE	0.1		0.3	
Δ THRUSTERS	0.1		0.3	
Δ MISSION ANALYSIS	0.1		0.3	
STS LAUNCH FEE		($53.8M)		($84.1M)
$84.1M { [ASE + UPPER STAGE + PAYLOAD] LENGTH / 0.75 (60') }	0.64 X 84.1		1.0 x 84.1	
OR				
$84.1M { [ASE + UPPER STAGE + PAYLOAD] WEIGHT / 0.75 (65,000 LB) }	0.632 X 84.1		1.0 x 84.1	
TOTAL LAUNCH COSTS		$59.58M		$94.24M
USEFUL PAYLOAD AT GEO		6030 LB		13,680 LB
TRANSPORT COST/USEFUL MASS AT GEO		$9765/LB		$6890/LB

FIGURE 1-9

USER COSTS VS PAYLOAD WEIGHT: GROUND BASED OH-3

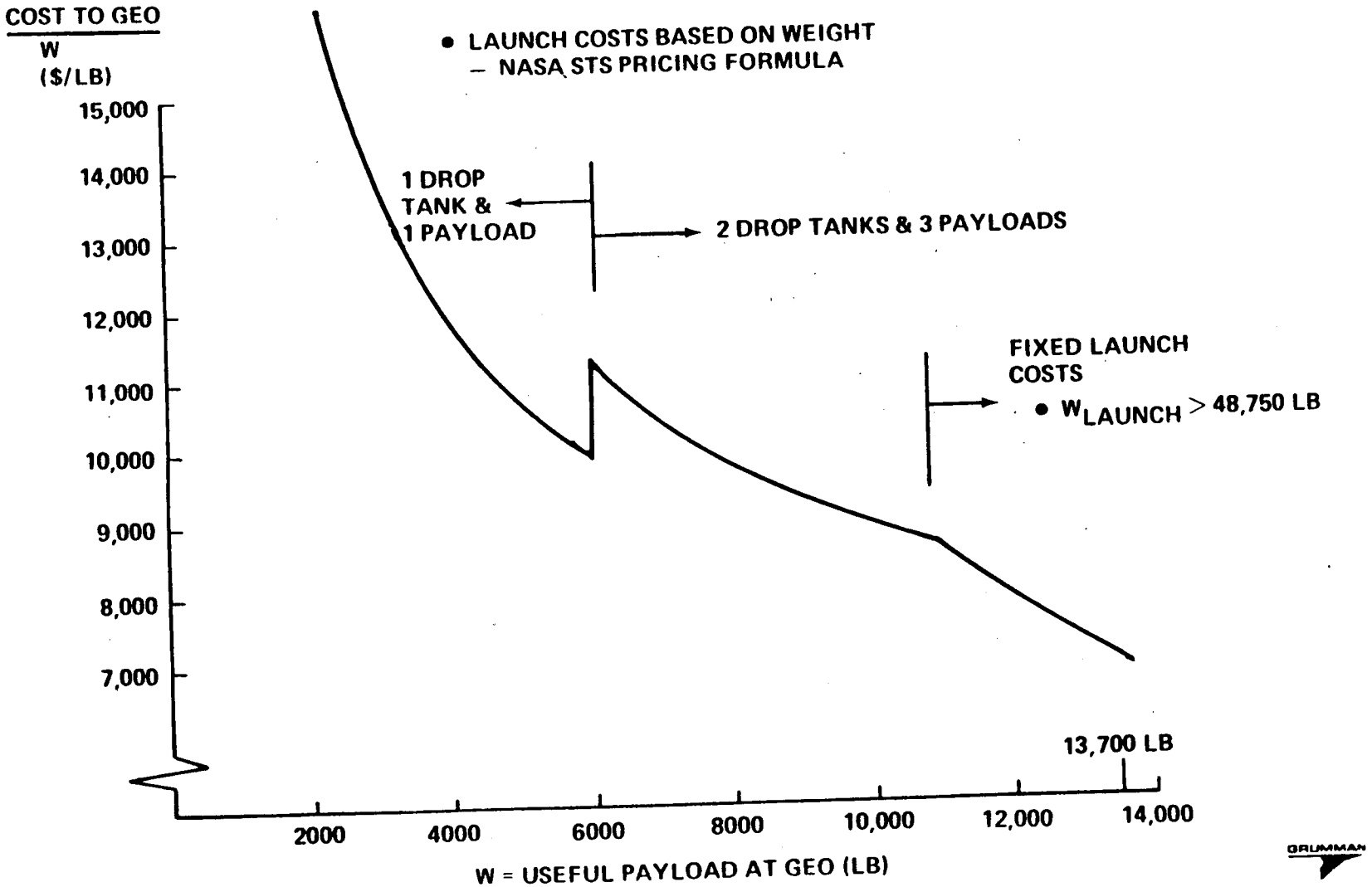

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FIGURE 1-10 # CONTRACTOR PROGRAM COSTS ('84$): OH-2M

IRAD

- SPARES + FIRST UNIT + DDT&E = $1.29 B

		PROGRAM COSTS IN MILLIONS (1984 $)			
	COST ELEMENT	DDT&E	1ST UNIT	SPARES	OPS
1.1	PROJ MGMT	19.2	3.7		0.08
1.2	SYST ENG & INT	60.1			
1.3	SPACE VEHICLE	806.8	153.5	12.3	4.5
	CREW MODULE	(282.8)	(75.7)	(6.2)	
	VEHICLE MODULE	(505.2)	(73.5)	(6.0)	(0.1)
	DROP TANKS	(18.8)	(4.4)	(0.4)	(4.4)
1.4	GRND SUPPORT SYST	103.8			
1.5	MISSIONS OPS	5.6			3.9
1.6	FLT SUPPORT EQ (ASE)	90.7			
1.7	SPACE TRANSPORT*				84.1*
1.8	INSTL, ASSY, & C/O		29.6		
1.9	SYST TEST & EVAL	18.4			
	PROGRAM TOTALS	$1104.7M	$187.3M	$12.5M	$92.6M

*"SPACE TRANSPORT" IS NASA CHARGE TO A USER OF STS CARGO BAY

- NO FLIGHT TEST SINCE AEROMANEUVERING TECHNOLOGY HAS BEEN ESTABLISHED BY SMALL DELIVERY ONLY AOTV (OH-3)

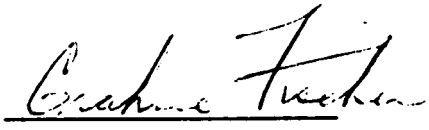
APPENDIX A

WORK BREAKDOWN STRUCTURE

AND

WBS DICTIONARY

AEROASSISTED ORBIT TRANSFER VEHICLE

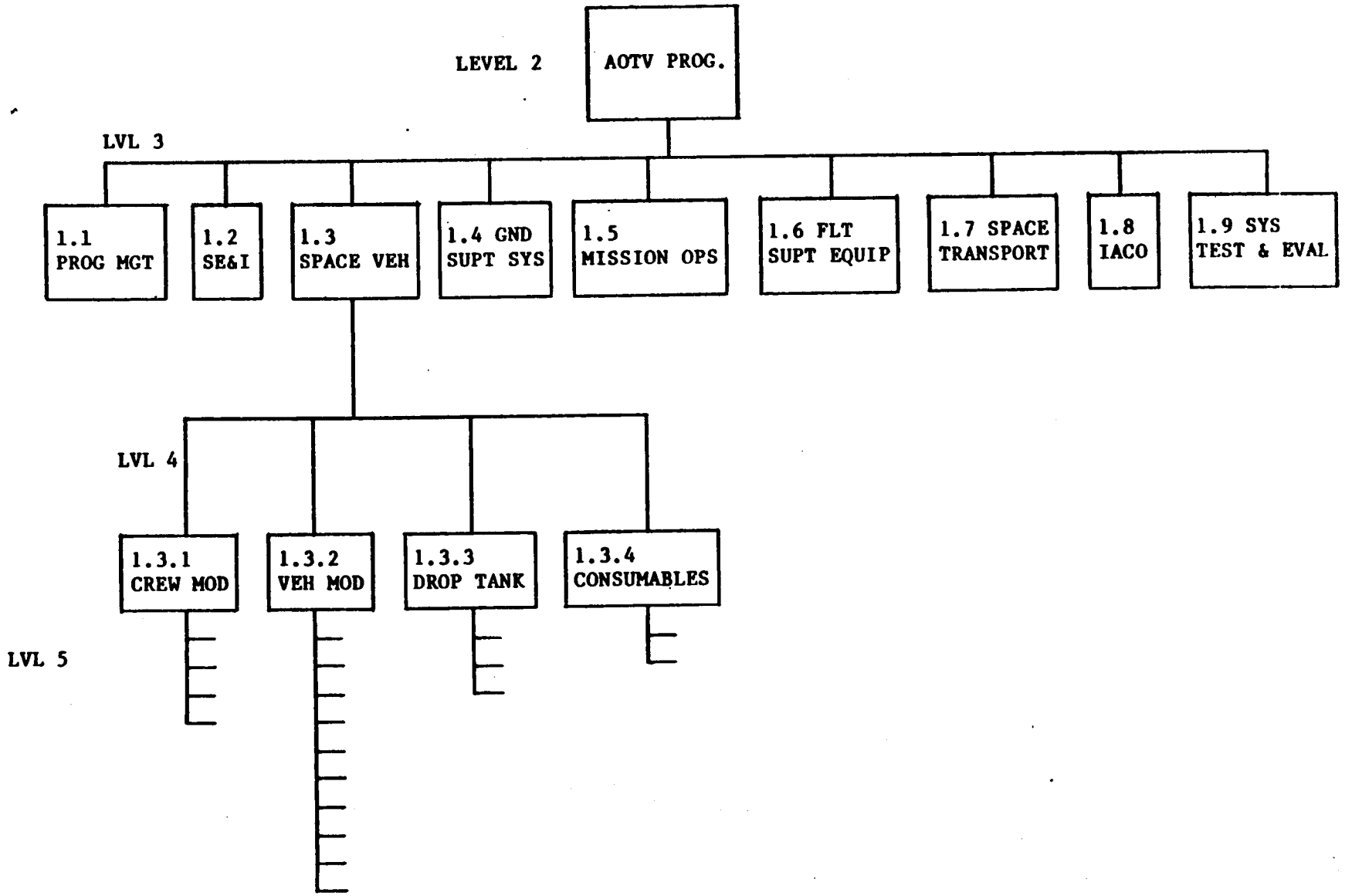
Approved 

G. Fischer

July 1983

AFA Revision October 1983

GRUMMAN AEROSPACE CORPORATION


LEVEL 2
AOTV PROG.
LVL 3
1.1 PROG MGT
1.2 SE&I
1.3 SPACE VEH
1.4 GND SUPT SYS
1.5 MISSION OPS
1.6 FLT SUPT EQUIP
1.7 SPACE TRANSPORT
1.8 IACO
1.9 SYS TEST & EVAL
LVL 4
1.3.1 CREW MOD
1.3.2 VEH MOD
1.3.3 DROP TANK
1.3.4 CONSUMABLES
LVL 5

WBS LEVEL 5 BREAKDOWN OF

1.3.1 CREW MODULE

1.3.1.1	Structure-Environment Protection	
1.3.1.2	Insulation	
1.3.1.3	Mechanisms	
	1.3.1.3.1	Manipulator
	1.3.1.3.2	Grappler
	1.3.1.3.3	Other
1.3.1.4	Electrical Power Supply	
1.3.1.5	Guidance, Navigation & Control	
1.3.1.6	Communication & Data Handling	
1.3.1.7	Controls & Displays	
1.3.1.8	Environmental Control Life Support	
1.3.1.9	Crew Accommodations	
1.3.1.10	On Board Software	
1.3.1.11	System Test & Evaluation	
1.3.1.12	Installation, Assembly & Checkout	
1.3.1.13	System Engineering & Integration	
1.3.1.14	Project Management	

WBS LEVEL 5 BREAKDOWN OF

1.3.2 VEHICLE MODULE

1.3.2.1	Aeroshell System
1.3.2.2	Propulsion System
	1.3.2.2.1 Engine
	1.3.2.2.2 Fuel System
	1.3.2.2.3 Gimbals & Actuators
	1.3.2.2.4 Tank Insulation
1.3.2.3	Payload System
1.3.2.4	Attitude Control Propulsion System
1.3.2.5	Guidance, Navigation & Control
1.3.2.6	Structure
	1.3.2.6.1 Shell
	1.3.2.6.2 Support
	1.3.2.6.3 Fuel Tank
	1.3.2.6.4 Oxidizer Tank
1.3.2.7	Mechanisms
	1.3.2.7.1 Berthing
	1.3.2.7.2 Flaps
	1.3.2.7.3 Other
1.3.2.8	EPS
1.3.2.9	Instrumentation
1.3.2.10	Communication & Data Handling

1.3.2.11	Thermal Control System
1.3.2.12	Rendezvous Radar
1.3.2.13	Systems Test & Evaluation
1.3.2.14	Integration, Assembly & Checkout
1.3.2.15	System Engineering & Integration
1.3.2.16	Program Management

WBS LEVEL 5 BREAKDOWN OF

1.3.3 DROP TANK

1.3.3.1	Structure
1.3.3.2	Insulation
1.3.3.3	Propulsion
1.3.3.4	Payload Support Structure
1.3.3.5	Stabilization
1.3.3.6	System Test & Evaluation
1.3.3.7	Installation, Assembly & Checkout
1.3.3.8	System Engineering & Integration
1.3.3.9	Project Management

1.3.4 CONSUMABLES

1.3.4.1	Fuel
1.3.4.2	Fuel Cell Reactants
1.3.4.3	Crew Provisions
1.3.4.4	ACPS Propellant

WBS LEVEL 5 BREAKDOWN OF

1.4 GROUND SUPPORT SYSTEM

1.4.1	Facilities
1.4.2	Trainers/Simulation
1.4.3	Logistics
1.4.4	Launch Support
1.4.5	Ground Support Equipment
1.4.5.1	Crew Module
1.4.5.2	Vehicle Module
1.4.5.3	Drop Tank
1.4.6	Support Software
1.4.7	Training

1.5 MISSION OPERATIONS

1.5.1	Pre-Launch Operations
1.5.1.1	Planning
1.5.1.2	Pre-Launch
1.5.2	Missions Operations
1.5.3	Turnaround Operations

WBS LEVEL 5 BREAKDOWN OF

1.6 FLIGHT SUPPORT EQUIPMENT

1.6.1	Cradle
1.6.2	Manipulator
1.6.3	Crew Seats
1.6.4	Tunnel
1.6.5	Docking Adapter
1.6.6	Expendables

1.7 SPACE TRANSPORT

1.7.1	STS Flights
1.7.2	STS Loiter
1.7.3	System Flight Test

WBS DICTIONARY

1.0 AOTV Program

This is the summing WBS for a total AOTV system. It collects and summarizes the resources needed to acquire and operate the AOTV, required space-transportation, and supporting ground segments over their total cycle.

1.1 Program Management

This element includes the management activities of planning, organizing, directing, coordinating, controlling and approving actions to ensure program success. It includes configuration management, documentation, management reviews, change boards, budgeting, schedule planning, construct administration and management of test programs, GFE, information systems, subcontractors, and procurement functions.

1.2 SE & I

SE & I is an abbreviation for system engineering and integration. This element includes the the following activities:

Requirements Analysis

Interface Definition

Design-to-Cost/Life Cycle Cost Analysis

Technical Performance Management

1.3 Space Vehicle

This element collects the costs and resources directly associated with the vehicle hardware. It includes costs for analysis, design, tooling, test, fabrication and checkout.

For each subsystem (structure, EPS, communications, etc.) of paragraphs 1.3.1, 1.3.2 & 1.3.3, a development and production cost is generated which includes design, test, subsystem test hardware, production, qualification and acceptance testing, and sub-system assembly.

1.3.1 Crew Module

This element sums the development and production costs for all components which provided a structural enclosure and life support for the crew of an AOTV. It also includes power supplies & distributions, mechanisms, software, tools, and, controls and displays which are used by the crew.

1.3.2 Vehicle Module

This element sums the development and production costs for all subsystems on or within the vehicle's aerodynamic shell.

1.3.3 Drop Tanks

This element sums the development and production costs for all subsystems which are attached to throw-away drop tanks. These include a tank or tanks, electrical, structural & fluid connectors plus a de-orbit system with a rocket motor.

1.3.4 Consummables

This element sums fuel and crew provisions for the operations phase.

1.4 Ground Support System

This element collects all resources needed to acquire and operate the ground segment. It covers all ground based facilities, equipment and software needed to support the vehicle in space. It exclude launch facilities and all ground support equipment used in support of flight hardware. It includes hardware and software directly associated with the ground equipment to control and maintain communication with the vehicle as well as mission data processing. It includes trainers and simulators, government furnished equipment, crew

procedures development, mission control center and data reduction center modification, and flight planning and analysis. It also includes test, evaluation and analysis efforts for labs, test chambers, and other test facilities.

1.5 Mission Operations

This WBS entry collects both operation phase manpower costs and the acquisition plus maintenance costs of any equipment which is necessary for spacecraft operations; however, since only flight-test operations would be included under acquisition, the majority of costs for this item would accrue in the operations phase.

1.6 Flight Support Equipment

This WBS entry collects equipment costs for space transportation related hardware which is used in the shuttle. These costs are in addition to the user charges of WBS item 1.7. These components are also known as Airborne Support Equipment.

1.7 Space Transportation

This WBS item accounts for the shuttle transportation costs to place an AOTV into orbit.

1.8 Integration, Assembly and Checkout

This element sums acquisition costs and resources needed to accomplish the integration of level 4 components to level 3. It includes testing and final assembly/checkout on earth. It also includes any final assembly or checkout in space before release of an AOTV from an Orbiter or Space Base.

1.9 System Test and Evaluation

Resources needed to integrate and test items 1.3, 1.4 and 1.6. It includes performance integration and ground tests to verify vehicle integrity and performance.

APPENDIX B

Input Echos and cost estimate printouts for configurations OH-3, OH-1, 38' GEO and H-1M.

***** NOTES ON SPACE MODEL INPUTS *****

THIS TABLE LISTS ONLY THOSE WBS ITEMS WHICH ARE COSTED BY # THRUPUT AND/OR PARAMETRIC COST DRIVERS
WHEN INPUTS ARE DOLLAR THRUPUTS; COL. 1 IS FOR DDT&E, COL. 2 IS FOR PRODUCTION, COL. 3 IS FOR OPERATIONS
WHEN INPUTS ARE WTS SPECIFIED AS KG,KG; COL. 1 IS FOR NON-REPLICATED WT, COL. 2 IS FOR TOTAL DRY WT.
WHEN INPUTS ARE WTS SPECIFIED AS KG; COL. 1 IS FOR TOTAL DRY WT.
QUANTITY PFU = PER FIRST UNIT, TOT = TOTAL PROD. QTY
COMMONALITY FACTOR 1 = NO COST REDUCTION DUE TO COST SHARING 0 = 100% COST REDUCTION DUE TO COMMONALITY
COMPLEXITY FACTOR 1 = SAME COMPLEXITY AS IN CER DATA BASE
SODEV (STATE OF DEVELOPMENT) FACTOR 1 = SAME SODEV AS IN CER DATA BASE

OH-3 INPUTS---- MODE

ITEM NO	WBS	COST ELEMENT	COST DRIVERS	INPUT1	INPUT2	INPUT3	INPUT4	QUANTITY PFU	QUANTITY TOT	PCT LRN	GRD TST	COMN DDT&E	COMPLEXITY DDT&E	COMPLEXITY TFU	SODEV DDT&E
105	1.3.2.1	AEROSHELL SYS	DL,SM	1.00	12.30	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
105	1.3.2.1	AEROSHELL SYS	DLR	0.0	0.0	0.040		1	2	0.90	1.00				
91	1.3.2.2.1	ENGINE	KGTHR,KG	0.0	50.40	0.0	0.0	4	8	0.90	1.00	1.00	1.00	1.00	1.00
92	1.3.2.2.2	FUEL SYS	KG,KG	13.00	274.40	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.60
14	1.3.2.2.4	TANK INSUL	DL,SM	0.50	1.92	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
130	1.3.2.3	PAYLOAD SYS	KG,KG	5.00	10.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
39	1.3.2.4	ACPS	KG,KG	48.00	189.60	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.60
29	1.3.2.5	G N & C	KG	196.60	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.19
128	1.3.2.6.1	SHELL	KG,KG	23.00	44.90	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
101	1.3.2.6.2	SUPPORT	KG,KG	132.00	179.60	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
102	1.3.2.6.3	FUEL TANK	KG,KG	15.00	15.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
102	1.3.2.6.3	FUEL TANK	DLR	0.0	0.0	0.010		1	2	0.90	1.00				
103	1.3.2.6.4	OXIDIZER TANK	KG,KG	10.00	10.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
103	1.3.2.6.4	OXIDIZER TANK	DLR	0.0	0.0	0.010		1	2	0.90	1.00				
21	1.3.2.7.1	BERTHING	KG,KG	91.60	124.70	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
22	1.3.2.7.2	FLAPS	KG,KG	87.30	87.30	0.0	0.0	2	4	0.90	1.00	1.00	1.00	1.00	1.00
23	1.3.2.8.3	CONV/DISTR	KG	219.50	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.19
34	1.3.2.9	INSTRUMENTATION	KG,KG	86.40	86.40	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
45	1.3.2.10	COMM/DATA HDL	KG,KG	21.30	21.30	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.25
41	1.3.3.1	STRUCTURE	KG,KG	374.20	374.20	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
42	1.3.3.2	INSULATION	DL,SM	0.0	48.30	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
44	1.3.3.4	P/L SPPT STRUCT	KG,KG	181.00	181.00	0.0	0.0	1	2	0.90	1.00	0.40	1.00	0.50	1.00
52	1.3.4.1	FUEL	KG	761.40	0.0	761.40	0.0	1	2	0.90	0.0	1.00	1.00	1.00	1.00
58	1.4.3	LOGISTICS	DLR	0.500	0.0	0.0		1	2	0.90	1.00				
59	1.4.4	LAUNCH SPPT	DLR	0.200	0.0	0.0		1	2	0.90	1.00				
64	1.4.6	SUPT SOFTWARE	DLR	4.000	0.0	0.0		1	2	0.90	1.00				
93	1.5.1.1	PLANNING	DLR	1.200	0.0	0.100		1	2	0.90	1.00				
94	1.5.1.2	PRE-LAUNCH	DLR	2.000	0.0	0.250		1	2	0.90	1.00				
95	1.5.2.1	PLANNING	DLR	0.200	0.0	0.200		1	2	0.90	1.00				
96	1.5.2.2	MISSION	DLR	0.0	0.0	0.020		1	2	0.90	1.00				
97	1.5.3.1	PLANNING	DLR	1.000	0.0	0.020		1	2	0.90	1.00				
98	1.5.3.2	TURNAROUND	DLR	0.0	0.0	1.000		1	2	0.90	1.00				
73	1.6.1	CRADLE	KG,KG	911.00	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
77	1.6.6	EXPENDABLES	DLR	0.001	0.0	0.001		1	2	0.90	1.00				
79	1.7.1	STS FLIGHTS	DL N	0.0	0.0	1.00	0.0	1	2	0.90	0.0	1.00	1.00	1.00	1.00
79	1.7.1	STS FLIGHTS	DLR	0.0	0.0	54.200		1	2	0.90	0.0				
81	1.7.3	SYS FLIGHT TEST	DLR	24.300	0.0	0.0		1	2	0.90	1.00				

**** NOTES ON SPACE MODEL OUTPUT ****

FIRST UNIT COST IS TOTAL PER QUANTITY SPECIFIED (SEE PFU QUANTITY INPUT COLUMN)
PRODUCTION COST IS TOTAL FOR THE PRODUCTION QUANTITY SPECIFIED (SEE TOTAL QUANTITY INPUT COLUMN)
G&A INCLUDED,PROFIT EXCLUDED

49	1.3.3.4	F/L SPPT STRUCT	KG,KG	181.00	181.00	0.0	0.0	1	2	0.90	1.00	0.40	1.00	0.50	1.00			
52	1.3.4.1	FUEL	KG	761.40	0.0	761.40	0.0	1	2	0.90	0.0	1.00	1.00	1.00	1.00			
58	1.4.3	LOGISTICS	DLR	0.500	0.0	0.0		1	2	0.90	1.00							
59	1.4.4	LAUNCH SPPT	DLR	0.200	0.0	0.0		1	2	0.90	1.00							
64	1.4.6	SUPT SOFTWARE	DLR	4.000	0.0	0.0		1	2	0.90	1.00							
93	1.5.1.1	PLANNING	DLR	1.200	0.0	0.120		1	2	0.90	1.00							
94	1.5.1.2	PRE-LAUNCH	DLR	2.000	0.0	0.200		1	2	0.90	1.00							
95	1.5.2.1	PLANNING	DLR	0.200	0.0	0.200		1	2	0.90	1.00							
96	1.5.2.2	MISSION	DLR	0.0	0.0	0.020		1	2	0.90	1.00							
97	1.5.3.1	PLANNING	DLR	1.000	0.0	0.020		1	2	0.90	1.00							
98	1.5.3.2	TURNAROUND	DLR	0.0	0.0	1.000		1	2	0.90	1.00							
73	1.6.1	CRADLE	KG,KG	911.00	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00			
77	1.6.6	EXPENDABLES	DLR	0.001	0.0	0.001		1	2	0.90	1.00							
79	1.7.1	STS FLIGHTS	DL N	0.0	0.0	1.00	0.0	1	2	0.90	0.0	1.00	1.00	1.00	1.00			
79	1.7.1	STS FLIGHTS	DLR	0.0	0.0	54.200		1	2	0.90	0.0							
81	1.7.3	SYS_FLIGHT_TEST	DLR	24.300	0.0	0.0		1	2	0.90	1.00							

****** NOTES ON SPACE MODEL OUTPUT ******

FIRST UNIT COST IS TOTAL PER QUANTITY SPECIFIED (SEE PFU QUANTITY INPUT COLUMN)
PRODUCTION COST IS TOTAL FOR THE PRODUCTION QUANTITY SPECIFIED (SEE TOTAL QUANTITY INPUT COLUMN)
G&A INCLUDED,PROFIT EXCLUDED

OH-3 LCC OUTPUT BY PROGRAM PHASE (MILLIONS OF 1984 CONSTANT DOLLARS)

WBS	COST ELEMENT	DDT&E ENG DES AND DEV	DDT&E GRD TEST HDWR	DDT&E TOTAL	PRODUCTION FIRST UNIT	PRODUCTION VEHICLE PROD	PRODUCTION INITIAL SPARES	PRODUCTION TOTAL	OPERATIONS OPER	OPERATIONS OPER SPARES	OPERATIONS TOTAL	TOTAL
1.0	AOTV PROGRAM	520.14	43.05	563.18	64.28	115.70	4.80	120.50	59.69	0.0	59.69	743.38
1.1	PROJ MGMT	10.20	0.0	10.20	1.26	2.27	0.0	2.27	0.05	0.0	0.05	12.52
1.2	S E & I	27.80	0.0	27.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.80
1.3	SPACE VEHICLE	315.11	43.05	358.16	52.69	94.84	4.80	99.64	3.85	0.0	3.85	461.65
1.3.2	VEHICLE MODULE	287.04	39.93	326.97	48.87	87.97	3.99	91.97	0.06	0.0	0.06	419.00
1.3.2.1	AEROSHELL SYS	1.44	1.21	2.64	1.21	2.17	0.12	2.29	0.04	0.0	0.04	4.98
1.3.2.2	PROPULSION SYS	3.05	3.34	6.39	3.34	6.01	0.33	6.34	0.0	0.0	0.0	12.73
1.3.2.2.1	ENGINE	0.0	3.13	3.13	3.13	5.63	0.31	5.95	0.0	0.0	0.0	9.08
1.3.2.2.2	FUEL SYS	2.33	0.11	2.44	0.11	0.19	0.01	0.20	0.0	0.0	0.0	2.64
1.3.2.2.4	TANK INSUL	0.72	0.10	0.82	0.10	0.18	0.01	0.19	0.0	0.0	0.0	1.01
1.3.2.3	PAYLOAD SYS	10.74	0.28	11.02	0.28	0.50	0.03	0.53	0.0	0.0	0.0	11.55
1.3.2.4	ACPS	3.64	3.04	6.69	3.04	5.48	0.30	5.78	0.0	0.0	0.0	12.47
1.3.2.5	G N & C	86.04	20.83	106.87	20.83	37.49	2.08	39.57	0.0	0.0	0.0	146.44
1.3.2.6	STRUCTURE	59.81	3.88	63.69	3.88	6.98	0.39	7.37	0.02	0.0	0.02	71.08
1.3.2.6.1	SHELL	19.16	0.87	20.02	0.87	1.56	0.09	1.65	0.0	0.0	0.0	21.67
1.3.2.6.2	SUPPORT	37.17	2.46	39.64	2.46	4.44	0.25	4.68	0.0	0.0	0.0	44.32
1.3.2.6.3	FUEL TANK	1.90	0.30	2.20	0.30	0.55	0.03	0.58	0.01	0.0	0.01	2.79
1.3.2.6.4	OXIDIZER TANK	1.59	0.24	1.83	0.24	0.44	0.02	0.46	0.01	0.0	0.01	2.30
1.3.2.7	MECHANISMS	64.13	4.45	68.58	4.45	8.01	0.45	8.46	0.0	0.0	0.0	77.04
1.3.2.7.1	BERTHING	32.36	1.87	34.23	1.87	3.37	0.19	3.56	0.0	0.0	0.0	37.79
1.3.2.7.2	FLAPS	31.77	2.58	34.35	2.58	4.64	0.26	4.90	0.0	0.0	0.0	39.25
1.3.2.8	EPS	2.47	0.53	3.00	0.53	0.96	0.05	1.01	0.0	0.0	0.0	4.01
1.3.2.8.3	CONV/DISTR	2.47	0.53	3.00	0.53	0.96	0.05	1.01	0.0	0.0	0.0	4.01

[illegible]	INSTRUMENTATION	17.77	1.36	19.35	1.36	2.45	0.14	2.58	0.0	0.0	0.0	21.93
1.3.2.10	COMM/DATA HDL	1.35	1.01	2.36	1.01	1.82	0.10	1.92	0.0	0.0	0.0	4.27
1.3.2.13	SYS TST & EVAL	7.52	0.0	7.52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.52
1.3.2.14	INSTL,ASSY,C/O	0.0	0.0	0.0	7.99	14.37	0.0	14.37	0.0	0.0	0.0	14.37
1.3.2.15	S E & I	23.24	0.0	23.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.24
1.3.2.16	PROJ MGMT	5.63	0.0	5.63	0.96	1.72	0.0	1.72	0.00	0.0	0.00	7.35
1.3.3	DROP TANK	28.06	3.12	31.17	3.81	6.86	0.81	7.67	3.78	0.0	3.78	42.62
1.3.3.1	STRUCTURE	7.74	1.75	9.49	1.75	3.15	0.18	3.33	1.75	0.0	1.75	14.57
1.3.3.2	INSULATION	0.0	0.13	0.13	0.13	0.23	0.01	0.24	0.13	0.0	0.13	0.49
1.3.3.4	P/L SPPT STRUCT	16.76	1.24	18.00	1.24	2.23	0.62	2.85	1.24	0.0	1.24	22.09
1.3.3.6	SYS TST & EVAL	0.73	0.0	0.73	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.73
1.3.3.7	INSTL,ASSY,C/O	0.0	0.0	0.0	0.62	1.12	0.0	1.12	0.62	0.0	0.62	1.74
1.3.3.8	S E & I	2.27	0.0	2.27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.27
1.3.3.9	PROJ MGMT	0.55	0.0	0.55	0.07	0.13	0.0	0.13	0.04	0.0	0.04	0.72
1.3.4	CONSUMABLES	0.01	0.0	0.01	0.0	0.0	0.0	0.0	0.01	0.0	0.01	0.03
1.3.4.1	FUEL	0.01	0.0	0.01	0.0	0.0	0.0	0.0	0.01	0.0	0.01	0.03
1.4	GND SPPT SYS	52.46	0.0	52.46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.46
1.4.2	TRAINERS/SIMUL	12.62	0.0	12.62	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.62
1.4.3	LOGISTICS	0.50	0.0	0.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.50
1.4.4	LAUNCH SPPT	0.20	0.0	0.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.20
1.4.5	GSE	29.52	0.0	29.52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.52
1.4.5.2	VEHICLE MODULE	28.14	0.0	28.14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.14
1.4.5.3	DROP TANK	1.38	0.0	1.38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.38
1.4.6	SUPT SOFTWARE	4.00	0.0	4.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.00
1.4.7	TRAINING	5.63	0.0	5.63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.63
1.5	MISSION OPS	4.40	0.0	4.40	0.0	0.0	0.0	0.0	1.59	0.0	1.59	5.99
1.5.1	PRE-LAUNCH OPS	3.20	0.0	3.20	0.0	0.0	0.0	0.0	0.35	0.0	0.35	3.55
1.5.1.1	PLANNING	1.20	0.0	1.20	0.0	0.0	0.0	0.0	0.10	0.0	0.10	1.30
1.5.1.2	PRE-LAUNCH	2.00	0.0	2.00	0.0	0.0	0.0	0.0	0.25	0.0	0.25	2.25
1.5.2	MISSIONS OPS	0.20	0.0	0.20	0.0	0.0	0.0	0.0	0.22	0.0	0.22	0.42
1.5.2.1	PLANNING	0.20	0.0	0.20	0.0	0.0	0.0	0.0	0.20	0.0	0.20	0.40
1.5.2.2	MISSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.02	0.02
1.5.3	TURNAROUND OPS	1.00	0.0	1.00	0.0	0.0	0.0	0.0	1.02	0.0	1.02	2.02
1.5.3.1	PLANNING	1.00	0.0	1.00	0.0	0.0	0.0	0.0	0.02	0.0	0.02	1.02
1.5.3.2	TURNAROUND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0	1.00	1.00
1.6	FLT SPPT EQUIP	77.36	0.0	77.36	0.0	0.0	0.0	0.0	0.00	0.0	0.00	77.36
1.6.1	CRADLE	77.36	0.0	77.36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.36
1.6.4	EXPENDABLES	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.00
1.7	SPACE TRANSPORT	24.30	0.0	24.30	0.0	0.0	0.0	0.0	54.20	0.0	54.20	78.50
1.7.1	STS FLIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.20	0.0	54.20	54.20
1.7.3	SYS FLIGHT TEST	24.30	0.0	24.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.30
1.9	INSTL,ASSY,C/O	0.0	0.0	0.0	10.33	18.60	0.0	18.60	0.0	0.0	0.0	18.60
1.9	SYS,TST & EVAL	8.50	0.0	8.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.50

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... [BLOCK] THE FOLLOWING NAMES ARE UNDEFINED.
VAR      VARI     PLOTS    PLOT     SCALE    LINEWT   AXIS
NUMBER   LINE     SYMBOL   EPLOT
LOAD SPACE CBANK CFACT CER22 SUM22
+++ R(00004) +++
DMSLI0740I EXECUTION BEGINS...
```

***** NOTES ON SPACE MODEL INPUTS *****

THIS TABLE LISTS ONLY THOSE WBS ITEMS WHICH ARE COSTED BY $ THRUPUT AND/OR PARAMETRIC COST DRIVERS
WHEN INPUTS ARE DOLLAR THRUPUTS; COL. 1 IS FOR DDT&E, COL. 2 IS FOR PRODUCTION, COL. 3 IS FOR OPERATIONS
WHEN INPUTS ARE WTS SPECIFIED AS KG,KG; COL. 1 IS FOR NON-REPLICATED WT, COL. 2 IS FOR TOTAL DRY WT.
WHEN INPUTS ARE WTS SPECIFIED AS KG; COL. 1 IS FOR TOTAL DRY WT.
QUANTITY PFU = PER FIRST UNIT, TOT = TOTAL PROD. QTY
COMMONALITY FACTOR 1 = NO COST REDUCTION DUE TO COST SHARING 0 = 100% COST REDUCTION DUE TO COMMONALITY
COMPLEXITY FACTOR 1 = SAME COMPLEXITY AS IN CER DATA BASE
SODEV (STATE OF DEVELOPMENT) FACTOR 1 = SAME SODEV AS IN CER DATA BASE

OH-1 INPUTS---- MODE

ITEM NO	WBS	COST ELEMENT	COST DRIVERS	INPUT1	INPUT2	INPUT3	INPUT4	QUANTITY PFU	QUANTITY TOT	PCT LRN	GRD TST	COMM DDT&E	COMPLEXITY DDT&E	COMPLEXITY TFU	SODEV NOISE
105	1.3.2.1	AEROSHELL SYS	DL,SM	1.00	18.60	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
105	1.3.2.1	AEROSHELL SYS	DLR	0.0	0.0	0.040		1	2	0.90	1.00				
91	1.3.2.2.1	ENGINE	KGTHR,KG	0.0	55.40	0.0	0.0	2	4	0.90	1.00	1.00	1.00	1.00	1.15
92	1.3.2.2.2	FUEL SYS	KG,KG	13.00	254.50	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.60
16	1.3.2.2.4	TANK INSUL	DL,SM	0.50	1.92	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
130	1.3.2.3	PAYLOAD SYS	KG,KG	5.00	10.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
39	1.3.2.4	ACPS	KG,KG	48.00	189.60	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.60
29	1.3.2.5	G N & C	KG	196.60	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.19
128	1.3.2.6.1	SHELL	KG,KG	35.00	69.90	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
101	1.3.2.6.2	SUPPORT	KG,KG	176.00	239.50	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
102	1.3.2.6.3	FUEL TANK	KG,KG	1.50	15.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
102	1.3.2.6.3	FUEL TANK	DLR	0.0	0.0	0.010		1	2	0.90	1.00				
103	1.3.2.6.4	OXIDIZER TANK	KG,KG	1.00	10.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
103	1.3.2.6.4	OXIDIZER TANK	DLR	0.0	0.0	0.010		1	2	0.90	1.00				
21	1.3.2.7.1	BERTHING	KG,KG	91.60	124.70	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
22	1.3.2.7.2	FLAPS	KG,KG	174.60	174.60	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
33	1.3.2.8.3	CONV/DISTR	KG	219.50	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.19
34	1.3.2.9	INSTRUMENTATION	KG,KG	86.40	86.40	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
35	1.3.2.10	COMM/DATA HDL	KG,KG	21.30	21.30	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.25
41	1.3.3.1	STRUCTURE	KG,KG	374.20	374.20	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
42	1.3.3.2	INSULATION	DL,SM	0.0	48.30	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
44	1.3.3.4	P/L SPPT STRUCT	KG,KG	181.00	181.00	0.0	0.0	1	2	0.90	1.00	0.40	1.00	0.50	1.00
52	1.3.4.1	FUEL	KG	761.40	0.0	761.40	0.0	1	2	0.90	0.0	1.00	1.00	1.00	1.00
58	1.4.3	LOGISTICS	DLR	0.500	0.0	0.0		1	2	0.90	1.00				
59	1.4.4	LAUNCH SPPT	DLR	0.200	0.0	0.0		1	2	0.90	1.00				
64	1.4.6	SUPT SOFTWARE	DLR	4.000	0.0	0.0		1	2	0.90	1.00				
93	1.5.1.1	PLANNING	DLR	1.200	0.0	0.100		1	2	0.90	1.00				
94	1.5.1.2	PRE-LAUNCH	DLR	2.000	0.0	0.250		1	2	0.90	1.00				
95	1.5.2.1	PLANNING	DLR	0.200	0.0	0.200		1	2	0.90	1.00				
96	1.5.2.2	MISSION	DLR	0.0	0.0	0.020		1	2	0.90	1.00				
97	1.5.3.1	PLANNING	DLR	1.000	0.0	0.020		1	2	0.90	1.00				
98	1.5.3.2	TURNAROUND	DLR	0.0	0.0	1.000		1	2	0.90	1.00				
73	1.6.1	CRADLE	KG,KG	911.00	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
77	1.6.6	EXPENDABLES	DLR	0.001	0.0	0.001		1	2	0.90	1.00				
79	1.7.1	STS FLIGHTS	DL N	0.0	0.0	1.00	0.0	1	2	0.90	0.0	1.00	1.00	1.00	1.00
79	1.7.1	STS FLIGHTS	DLR	0.0	0.0	59.700		1	2	0.90	0.0				
81	1.7.3	SYS FLIGHT TEST	DLR	29.100	0.0	0.0		1	2	0.90	1.00				

**** NOTES ON SPACE MODEL OUTPUT ****

FIRST UNIT COST IS TOTAL PER QUANTITY SPECIFIED (SEE PFU QUANTITY INPUT COLUMN)
PRODUCTION COST IS TOTAL FOR THE PRODUCTION QUANTITY SPECIFIED (SEE TOTAL QUANTITY INPUT COLUMN)
G&A INCLUDED,PROFIT EXCLUDED

OH-1 LCC OUTPUT BY PROGRAM PHASE (MILLIONS OF 1984 CONSTANT DOLLARS)

WBS	COST ELEMENT	DDT&E			PRODUCTION				OPERATIONS			
		ENG DES AND DEV	GRD TEST HDWR	TOTAL	FIRST UNIT	VEHICLE PROD	INITIAL SPARES	TOTAL	OPER	OPER SPARES	TOTAL	TOTAL
1.0	AOTV PROGRAM	547.02	43.22	590.24	64.54	116.17	4.82	120.99	65.19	0.0	65.19	776.42
1.1	PROJ MGMT	10.73	0.0	10.73	1.27	2.28	0.0	2.28	0.05	0.0	0.05	13.06
1.2	S E & I	29.31	0.0	29.31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.31
1.3	SPACE VEHICLE	332.22	43.22	375.44	52.90	95.22	4.82	100.04	3.85	0.0	3.85	479.33
1.3.2	VEHICLE MODULE	304.15	40.10	344.26	49.09	88.36	4.01	92.37	0.06	0.0	0.06	436.68
1.3.2.1	AEROSHELL SYS	1.44	1.83	3.26	1.83	3.29	0.18	3.47	0.04	0.0	0.04	6.77
1.3.2.2	PROPULSION SYS	3.05	2.12	5.17	2.12	3.82	0.21	4.03	0.0	0.0	0.0	9.20
1.3.2.2.1	ENGINE	0.0	1.91	1.91	1.91	3.44	0.19	3.63	0.0	0.0	0.0	5.54
1.3.2.2.2	FUEL SYS	2.33	0.11	2.44	0.11	0.19	0.01	0.20	0.0	0.0	0.0	2.64
1.3.2.2.4	TANK INSUL	0.72	0.10	0.82	0.10	0.18	0.01	0.19	0.0	0.0	0.0	1.01
1.3.2.3	PAYLOAD SYS	10.74	0.28	11.02	0.28	0.50	0.03	0.53	0.0	0.0	0.0	11.55
1.3.2.4	ACPS	3.64	3.04	6.69	3.04	5.48	0.30	5.78	0.0	0.0	0.0	12.47
1.3.2.5	G N & C	86.04	20.83	106.87	20.83	37.49	2.08	39.57	0.0	0.0	0.0	146.44
1.3.2.6	STRUCTURE	65.20	4.82	70.01	4.82	8.67	0.48	9.15	0.02	0.0	0.02	79.17
1.3.2.6.1	SHELL	22.46	1.21	23.68	1.21	2.18	0.12	2.30	0.0	0.0	0.0	25.98
1.3.2.6.2	SUPPORT	41.46	3.06	44.52	3.06	5.51	0.31	5.81	0.0	0.0	0.0	50.33
1.3.2.6.3	FUEL TANK	0.69	0.30	1.00	0.30	0.55	0.03	0.58	0.01	0.0	0.01	1.58
1.3.2.6.4	OXIDIZER TANK	0.58	0.24	0.82	0.24	0.44	0.02	0.46	0.01	0.0	0.01	1.30
1.3.2.7	MECHANISMS	73.69	4.29	77.98	4.29	7.71	0.43	8.14	0.0	0.0	0.0	86.12
1.3.2.7.1	BERTHING	32.36	1.87	34.23	1.87	3.37	0.19	3.56	0.0	0.0	0.0	37.79
1.3.2.7.2	FLAPS	41.33	2.41	43.74	2.41	4.34	0.24	4.58	0.0	0.0	0.0	48.33
1.3.2.8	EPS	2.47	0.53	3.00	0.53	0.96	0.05	1.01	0.0	0.0	0.0	4.01
1.3.2.8.3	CONV/DISTR	2.47	0.53	3.00	0.53	0.96	0.05	1.01	0.0	0.0	0.0	4.01
1.3.2.9	INSTRUMENTATION	17.99	1.36	19.35	1.36	2.45	0.14	2.58	0.0	0.0	0.0	21.93
1.3.2.10	COMM/DATA HDL	1.35	1.01	2.36	1.01	1.82	0.10	1.92	0.0	0.0	0.0	4.27
1.3.2.13	SYS TST & EVAL	7.97	0.0	7.97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.97
1.3.2.14	INSTL,ASSY,C/O	0.0	0.0	0.0	8.02	14.44	0.0	14.44	0.0	0.0	0.0	14.44
1.3.2.15	S E & I	24.62	0.0	24.62	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.62
1.3.2.16	PROJ MGMT	5.96	0.0	5.96	0.96	1.73	0.0	1.73	0.00	0.0	0.00	7.70
1.3.3	DROP TANK	28.06	3.12	31.17	3.81	6.86	0.81	7.67	3.78	0.0	3.78	42.62
1.3.3.1	STRUCTURE	7.74	1.75	9.49	1.75	3.15	0.18	3.33	1.75	0.0	1.75	14.57
1.3.3.2	INSULATION	0.0	0.13	0.13	0.13	0.23	0.01	0.24	0.13	0.0	0.13	0.49
1.3.3.4	P/L SPPT STRUCT	16.76	1.24	18.00	1.24	2.23	0.62	2.85	1.24	0.0	1.24	22.09
1.3.3.6	SYS TST & EVAL	0.73	0.0	0.73	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.73
1.3.3.7	INSTL,ASSY,C/O	0.0	0.0	0.0	0.62	1.12	0.0	1.12	0.62	0.0	0.62	1.74
1.3.3.8	S E & I	2.27	0.0	2.27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.27
1.3.3.9	PROJ MGMT	0.55	0.0	0.55	0.07	0.13	0.0	0.13	0.04	0.0	0.04	0.72

1.3.4	CONSUMABLES	0.01	0.0	0.01	0.0	0.0	0.0	0.0	0.01	0.0	0.01	0.03
1.3.4.1	FUEL	0.01	0.0	0.01	0.0	0.0	0.0	0.0	0.01	0.0	0.01	0.03
1.4	GND SPPT SYS	54.94	0.0	54.94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.94
1.4.2	TRAINERS/SIMUL	13.17	0.0	13.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.17
1.4.3	LOGISTICS	0.50	0.0	0.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.50
1.4.4	LAUNCH SPPT	0.20	0.0	0.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.20
1.4.5	GSE	31.19	0.0	31.19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.19
1.4.5.2	VEHICLE MODULE	29.82	0.0	29.82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.82
1.4.5.3	DROP TANK	1.38	0.0	1.38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.38
1.4.6	SUPT SOFTWARE	4.00	0.0	4.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.00
1.4.7	TRAINING	5.88	0.0	5.88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.88
1.5	MISSION OPS	4.40	0.0	4.40	0.0	0.0	0.0	0.0	1.59	0.0	1.59	5.99
1.5.1	PRE-LAUNCH OPS	3.20	0.0	3.20	0.0	0.0	0.0	0.0	0.35	0.0	0.35	3.55
1.5.1.1	PLANNING	1.20	0.0	1.20	0.0	0.0	0.0	0.0	0.10	0.0	0.10	1.30
1.5.1.2	PRE-LAUNCH	2.00	0.0	2.00	0.0	0.0	0.0	0.0	0.25	0.0	0.25	2.25
1.5.2	MISSIONS OPS	0.20	0.0	0.20	0.0	0.0	0.0	0.0	0.22	0.0	0.22	0.42
1.5.2.1	PLANNING	0.20	0.0	0.20	0.0	0.0	0.0	0.0	0.20	0.0	0.20	0.40
1.5.2.2	MISSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.02	0.02
1.5.3	TURNAROUND OPS	1.00	0.0	1.00	0.0	0.0	0.0	0.0	1.02	0.0	1.02	2.02
1.5.3.1	PLANNING	1.00	0.0	1.00	0.0	0.0	0.0	0.0	0.02	0.0	0.02	1.02
1.5.3.2	TURNAROUND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0	1.00	1.00
1.6	FLT SPPT EQUIP	77.36	0.0	77.36	0.0	0.0	0.0	0.0	0.00	0.0	0.00	77.36
1.6.1	CRADLE	77.36	0.0	77.36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.36
1.6.6	EXPENDABLES	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.00
1.7	SPACE TRANSPORT	29.10	0.0	29.10	0.0	0.0	0.0	0.0	59.70	0.0	59.70	88.80
1.7.1	STS FLIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	59.70	0.0	59.70	59.70
1.7.3	SYS FLIGHT TEST	29.10	0.0	29.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.10
1.8	INSTL,ASSY,C/O	0.0	0.0	0.0	10.37	18.67	0.0	18.67	0.0	0.0	0.0	18.67
1.9	SYS TST & EVAL	8.96	0.0	8.96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.96

Ri

space
TYPE WBS DATA FILE NAME
.wbs22
TYPE CER MODEL FILE NAME
.cer22
TYPE COST FACTOR MODEL FILE NAME
.sum22
TYPE COST VARIANCE MODEL FILE NAME
.
TYPE INPUT DATA FILE NAME
.data22b
TYPE ANNUAL FUNDING DATA FILE NAME
.
DMSFLD023E NO FILETYPE SPECIFIED.

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NO FILETYPE SPECIFIED.
FILEDEF 03 DISK DATA
+++ R(00024) +++
DMSLI0201W THE FOLLOWING NAMES ARE UNDEFINED:
CURR    VARI    PLOTS    PLOT    SCALE    LINEWT    AXIS
NUMBER  LINE    SYMBOL   EPLOT
LOAD SPACE CRANK CFACT CER22 SUM22
+++ R(00004) +++
DMSLI0740I EXECUTION BEGINS...
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GE 38 10/4/83

ORIGINAL PAGE IS OF POOR QUALITY

******* NOTES ON SPACE MODEL INPUTS *******

THIS TABLE LISTS ONLY THOSE WBS ITEMS WHICH ARE COSTED BY $ THRUPUT AND/OR PARAMETRIC COST DRIVERS
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WHEN INPUTS ARE WTS SPECIFIED AS KG,KG; COL. 1 IS FOR NON-REPLICATED WT, COL. 2 IS FOR TOTAL DRY WT.
WHEN INPUTS ARE WTS SPECIFIED AS KG; COL. 1 IS FOR TOTAL DRY WT.
QUANTITY PFU = PER FIRST UNIT, TOT = TOTAL PROD. QTY
COMMONALITY FACTOR 1 = NO COST REDUCTION DUE TO COST-SHARING 0 = 100% COST REDUCTION DUE TO COMMONALITY
COMPLEXITY FACTOR 1 = SAME COMPLEXITY AS IN CER DATA BASE
GODEV (STATE OF DEVELOPMENT) FACTOR 1 = SAME GODEV AS IN CER DATA BASE

GE 38 GEO DEL INPUTS---- MODE

ITEM NO	WBS	COST ELEMENT	COST DRIVERS	INPUT1	INPUT2	INPUT3	INPUT4	QUANTITY PFU	QUANTITY TOT	PCT LRN	GRD TST	COMM DDT&E	COMPLEXITY DDT&E	COMPLEXITY TFU	GODEV DDT&E
105	1.3.2.1	AEROSHELL SYS	DL,SM	1.00	114.50	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
105	1.3.2.1	AEROSHELL SYS	DLR	0.0	0.0	0.080		1	2	0.90	1.00				
91	1.3.2.2.1	ENGINE	KGTHR,KG	0.0	213.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.15
92	1.3.2.2.2	FUEL SYS	KG,KG	15.00	289.90	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.60
11	1.3.2.2.3	GIMBALS & ACT.	KG,KG	23.70	23.70	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
16	1.3.2.2.4	TANK INSUL	DL,SM	0.50	86.50	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
130	1.3.2.3	PAYLOAD SYS	KG,KG	5.00	10.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
39	1.3.2.4	ACPS	KG,KG	48.40	193.40	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.60
29	1.3.2.5	G N & C	KG	215.30	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.19
128	1.3.2.6.1	SHELL	KG,KG	795.00	1590.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
33	1.3.2.8.3	CONV/DISTR	KG	329.30	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.19
34	1.3.2.9	INSTRUMENTATION	KG,KG	94.66	94.66	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
35	1.3.2.10	COMM/DATA HDL	KG,KG	23.30	23.30	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.25
52	1.3.4.1	FUEL	KG	2551.00	0.0	2551.00	0.0	1	2	0.90	0.0	1.00	1.00	1.00	1.00
58	1.4.3	LOGISTICS	DLR	0.500	0.0	0.0		1	2	0.90	1.00				
59	1.4.4	LAUNCH SPPT	DLR	0.200	0.0	0.0		1	2	0.90	1.00				
64	1.4.6	SUPT SOFTWARE	DLR	4.000	0.0	0.0		1	2	0.90	1.00				
93	1.5.1.1	PLANNING	DLR	1.200	0.0	0.100		1	2	0.90	1.00				
94	1.5.1.2	PRE-LAUNCH	DLR	2.000	0.0	0.250		1	2	0.90	1.00				
95	1.5.2.1	PLANNING	DLR	0.200	0.0	0.200		1	2	0.90	1.00				
96	1.5.2.2	MISSION	DLR	0.0	0.0	0.020		1	2	0.90	1.00				
97	1.5.3.1	PLANNING	DLR	1.000	0.0	0.020		1	2	0.90	1.00				
98	1.5.3.2	TURNAROUND	DLR	0.0	0.0	1.000		1	2	0.90	1.00				
73	1.6.1	CRADLE	KG,KG	911.00	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
77	1.6.6	EXPENDABLES	DLR	0.001	0.0	0.001		1	2	0.90	1.00				
79	1.7.1	STS FLIGHTS	DL N	0.0	0.0	1.00	0.0	1	2	0.90	0.0	1.00	1.00	1.00	1.00
79	1.7.1	STS FLIGHTS	DLR	0.0	0.0	84.100		1	2	0.90	0.0				
81	1.7.3	SYS FLIGHT TEST	DLR	71.000	0.0	0.0		1	2	0.90	1.00				

****** NOTES ON SPACE MODEL OUTPUT ******

FIRST UNIT COST IS TOTAL PER QUANTITY SPECIFIED (SEE PFU QUANTITY INPUT COLUMN)
PRODUCTION COST IS TOTAL FOR THE PRODUCTION QUANTITY SPECIFIED (SEE TOTAL QUANTITY INPUT COLUMN)
G&A INCLUDED, PROFIT EXCLUDED

GE 38 GEO DEL LCC OUTPUT BY PROGRAM PHASE (MILLIONS OF 1984 CONSTANT DOLLARS)

WBS	COST ELEMENT	DDT&E ENG DES AND DEV	DDT&E GRD TEST HDWR	DDT&E TOTAL	PRODUCTION FIRST UNIT	PRODUCTION VEHICLE PROD	PRODUCTION INITIAL SPARES	PRODUCTION TOTAL	OPERATIONS OPER	OPERATIONS OPER SPARES	OPERATIONS TOTAL	TOTAL
1.0	AOTV PROGRAM	499.91	57.76	557.67	86.25	155.25	5.78	161.02	85.83	0.0	85.83	804.53
1.1	PROJ MGMT	9.80	0.0	9.80	1.69	3.04	0.0	3.04	0.02	0.0	0.02	12.86
1.2	S E & I	23.05	0.0	23.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.05
1.3	SPACE VEHICLE	261.18	57.76	318.94	70.70	127.25	5.78	133.03	0.12	0.0	0.12	452.09
1.3.2	VEHICLE MODULE	261.13	57.76	318.89	70.70	127.25	5.78	133.03	0.08	0.0	0.08	452.00
1.3.2.1	AEROSHELL SYS	1.44	11.24	12.68	11.24	20.23	1.12	21.36	0.08	0.0	0.08	34.11
1.3.2.2	PROPULSION SYS	22.63	4.89	27.52	4.89	8.80	0.49	9.29	0.0	0.0	0.0	36.80
1.3.2.2.1	ENGINE	0.0	4.08	4.08	4.08	7.35	0.41	7.76	0.0	0.0	0.0	11.84
1.3.2.2.2	FUEL SYS	2.54	0.12	2.66	0.12	0.22	0.01	0.23	0.0	0.0	0.0	2.89
1.3.2.2.3	GIMBALS & ACT.	19.37	0.54	19.91	0.54	0.97	0.05	1.02	0.0	0.0	0.0	20.93
1.3.2.2.4	TANK INSUL	0.72	0.15	0.86	0.15	0.26	0.01	0.28	0.0	0.0	0.0	1.14
1.3.2.3	PAYLOAD SYS	10.74	0.28	11.02	0.28	0.50	0.03	0.53	0.0	0.0	0.0	11.55
1.3.2.4	ACPS	3.67	3.08	6.75	3.08	5.54	0.31	5.85	0.0	0.0	0.0	12.59
1.3.2.5	G N & C	91.69	22.20	113.89	22.20	39.95	2.22	42.17	0.0	0.0	0.0	156.06
1.3.2.6	STRUCTURE	73.46	12.71	86.18	12.71	22.89	1.27	24.16	0.0	0.0	0.0	110.33
1.3.2.6.1	SHELL	73.46	12.71	86.18	12.71	22.89	1.27	24.16	0.0	0.0	0.0	110.33
1.3.2.8	EPS	3.49	0.74	4.22	0.74	1.33	0.07	1.40	0.0	0.0	0.0	5.63
1.3.2.8.3	CONV/DISTR	3.49	0.74	4.22	0.74	1.33	0.07	1.40	0.0	0.0	0.0	5.63
1.3.2.9	INSTRUMENTATION	19.45	1.52	20.97	1.52	2.73	0.15	2.89	0.0	0.0	0.0	23.86
1.3.2.10	COMM/DATA HDL	1.47	1.10	2.58	1.10	1.99	0.11	2.10	0.0	0.0	0.0	4.67
1.3.2.13	SYS TST & EVAL	6.84	0.0	6.84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.84
1.3.2.14	INSTL,ASSY,C/O	0.0	0.0	0.0	11.55	20.79	0.0	20.79	0.0	0.0	0.0	20.79
1.3.2.15	S E & I	21.14	0.0	21.14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.14
1.3.2.16	PROJ MGMT	5.12	0.0	5.12	1.39	2.50	0.0	2.50	0.00	0.0	0.00	7.62
1.3.4	CONSUMABLES	0.04	0.0	0.04	0.0	0.0	0.0	0.0	0.04	0.0	0.04	0.09
1.3.4.1	FUEL	0.04	0.0	0.04	0.0	0.0	0.0	0.0	0.04	0.0	0.04	0.09
1.4	GND SPPT SYS	46.08	0.0	46.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.08
1.4.2	TRAINERS/SIMUL	10.91	0.0	10.91	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.91
1.4.3	LOGISTICS	0.50	0.0	0.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.50
1.4.4	LAUNCH SPPT	0.20	0.0	0.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.20
1.4.5	GSE	25.60	0.0	25.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.60
1.4.5.2	VEHICLE MODULE	25.60	0.0	25.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.60
1.4.6	SUPT SOFTWARE	4.00	0.0	4.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.00
1.4.7	TRAINING	4.87	0.0	4.87	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.87
1.5	MISSION OPS	4.40	0.0	4.40	0.0	0.0	0.0	0.0	1.59	0.0	1.59	5.99
1.5.1	PRE-LAUNCH OPS	3.20	0.0	3.20	0.0	0.0	0.0	0.0	0.35	0.0	0.35	3.55
1.5.1.1	PLANNING	1.20	0.0	1.20	0.0	0.0	0.0	0.0	0.10	0.0	0.10	1.30
1.5.1.2	PRE-LAUNCH	2.00	0.0	2.00	0.0	0.0	0.0	0.0	0.25	0.0	0.25	2.25

1.5.1.1	PLANNING	1.20	0.0	1.20	0.0	0.0	0.0	0.0	0.10	0.0	0.10	1.30
1.5.1.2	PRE-LAUNCH	2.00	0.0	2.00	0.0	0.0	0.0	0.0	0.25	0.0	0.25	2.25
1.5.2	MISSIONS OPS	0.20	0.0	0.20	0.0	0.0	0.0	0.0	0.22	0.0	0.22	0.42
1.5.2.1	PLANNING	0.20	0.0	0.20	0.0	0.0	0.0	0.0	0.20	0.0	0.20	0.40
1.5.2.2	MISSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.02	0.02
1.5.3	TURNAROUND OPS	1.00	0.0	1.00	0.0	0.0	0.0	0.0	1.02	0.0	1.02	2.02
1.5.3.1	PLANNING	1.00	0.0	1.00	0.0	0.0	0.0	0.0	0.02	0.0	0.02	1.02
1.5.3.2	TURNAROUND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0	1.00	1.00
1.6	FLT SPPT EQUIP	77.36	0.0	77.36	0.0	0.0	0.0	0.0	0.00	0.0	0.00	77.36
1.6.1	CRADLE	77.36	0.0	77.36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.36
1.6.6	EXPENDABLES	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.00
1.7	SPACE TRANSPORT	71.00	0.0	71.00	0.0	0.0	0.0	0.0	84.10	0.0	84.10	155.10
1.7.1	STS FLIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.10	0.0	84.10	84.10
1.7.3	SYS FLIGHT TEST	71.00	0.0	71.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.00
1.8	INSTL,ASSY,C/O	0.0	0.0	0.0	13.86	24.95	0.0	24.95	0.0	0.0	0.0	24.95
1.9	SYS TST & EVAL	7.05	0.0	7.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.05

H-1M 10/4/
OH-2M
LB-38

***** NOTES ON SPACE MODEL INPUTS *****

THIS TABLE LISTS ONLY THOSE WBS ITEMS WHICH ARE COSTED BY A THRUPUT AND/OR PARAMETRIC COST DRIVERS
WHEN INPUTS ARE DOLLAR THRUPUTS; COL. 1 IS FOR DDT&E, COL. 2 IS FOR PRODUCTION, COL. 3 IS FOR OPERATIONS
WHEN INPUTS ARE WTS SPECIFIED AS KG,KG; COL. 1 IS FOR NON-REPLICATED WT, COL. 2 IS FOR TOTAL DRY WT.
WHEN INPUTS ARE WTS SPECIFIED AS KG; COL. 1 IS FOR TOTAL DRY WT.
QUANTITY PFU = PER FIRST UNIT, TOT = TOTAL PROD. QTY
COMMONALITY FACTOR 1 = NO COST REDUCTION DUE TO COST SHARING 0 = 100% COST REDUCTION DUE TO COMMONALITY
COMPLEXITY FACTOR 1 = SAME COMPLEXITY AS IN CER DATA BASE
SODEV (STATE OF DEVELOPMENT) FACTOR 1 = SAME SODEV AS IN CER DATA BASE

H-1M INPUTS---- MODE

ITEM NO	WBS	COST ELEMENT	COST DRIVERS	INPUT1	INPUT2	INPUT3	INPUT4	QUANTITY PFU	QUANTITY TOT	PCT LRN	GRD TST	COMN DDT&E	COMPLEXITY DDT&E	COMPLEXITY TFU	SODEV DDT&E
6	1.3.1.1	STRUC-ENV PROT	KG,KG	480.00	549.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
9	1.3.1.3.1	MANIPULATOR	KG,KG	0.0	215.00	0.0	0.0	2	4	0.90	1.00	1.00	2.00	2.00	0.86
10	1.3.1.3.2	GRAPPLER	KG,KG	0.0	55.00	0.0	0.0	1	2	0.90	1.00	1.00	0.50	0.50	0.86
110	1.3.1.3.3	OTHER MECHANISMS	KG,KG	99.80	270.30	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
14	1.3.1.4.2	CONV/DISTR	KG	324.50	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.0
17	1.3.1.6	COMM/DATA HDL	KG,KG	62.70	62.70	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.25
18	1.3.1.7	CONT/DISPLAYS	KG,KG	525.80	525.80	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.19
19	1.3.1.8	ECLS	KG,KG	276.40	326.70	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.25
20	1.3.1.9	CREW ACCOMMOD.	KG,KG	264.00	377.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.25
68	1.3.1.10	O/B SOFTWARE	DLR	28.300	0.0	0.0		1	2	0.90	1.00				
105	1.3.2.1	AEROSHELL SYS	DL,SM	1.00	127.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
105	1.3.2.1	AEROSHELL SYS	DLR	0.0	0.0	0.080		1	2	0.90	1.00				
91	1.3.2.2.1	ENGINE	KGTHR,KG	0.0	55.38	0.0	0.0	4	8	0.90	1.00	1.00	1.15	1.00	1.00
92	1.3.2.2.2	FUEL SYS	KG,KG	17.00	334.30	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.60
16	1.3.2.2.4	TANK INSUL	DL,SM	0.50	33.20	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
130	1.3.2.3	PAYLOAD SYS	KG,KG	80.00	157.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
39	1.3.2.4	ACPS	KG,KG	57.00	224.50	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.60
29	1.3.2.5	G N & C	KG	225.60	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.19
128	1.3.2.6.1	SHELL	KG,KG	250.00	499.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
101	1.3.2.6.2	SUPPORT	KG,KG	293.40	399.20	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
102	1.3.2.6.3	FUEL TANK	KG,KG	2.00	20.00	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
102	1.3.2.6.3	FUEL TANK	DLR	0.0	0.0	0.010		1	2	0.90	1.00				
103	1.3.2.6.4	OXIDIZER TANK	KG,KG	109.80	109.80	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
103	1.3.2.6.4	OXIDIZER TANK	DLR	0.0	0.0	0.010		1	2	0.90	1.00				
21	1.3.2.7.1	BERTHING	KG,KG	121.00	164.70	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
22	1.3.2.7.2	FLAPS	KG,KG	289.40	289.40	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
111	1.3.2.7.3	OTHER	KG,KG	99.80	99.80	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
33	1.3.2.8.3	CONV/DISTR	KG	449.00	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.19
34	1.3.2.9	INSTRUMENTATION	KG,KG	99.20	99.20	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
35	1.3.2.10	COMM/DATA HDL	KG,KG	24.50	24.50	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	0.25
41	1.3.3.1	STRUCTURE	KG,KG	189.60	189.60	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
42	1.3.3.2	INSULATION	DL,SM	0.0	57.70	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
52	1.3.4.1	FUEL	KG	2994.00	0.0	2994.00	0.0	1	2	0.90	0.0	1.00	1.00	1.00	1.00
54	1.3.4.3	CREW PROV	N	2.00	0.0	2.00	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00
58	1.4.3	LOGISTICS	DLR	0.500	0.0	0.0		1	2	0.90	1.00				
59	1.4.4	LAUNCH SPPT	DLR	0.400	0.0	0.0		1	2	0.90	1.00				
64	1.4.6	SUPT SOFTWARE	DLR	4.000	0.0	0.0		1	2	0.90	1.00				
93	1.5.1.1	PLANNING	DLR	2.700	0.0	0.400		1	2	0.90	1.00				
94	1.5.1.2	PRE-LAUNCH	DLR	4.500	0.0	0.500		1	2	0.90	1.00				
95	1.5.2.1	PLANNING	DLR	2.400	0.0	0.600		1	2	0.90	1.00				
96	1.5.2.2	MISSION	DLR	0.0	0.0	0.600		1	2	0.90	1.00				
97	1.5.3.1	PLANNING	DLR	1.500	0.0	0.020		1	2	0.90	1.00				
98	1.5.3.2	TURNAROUND	DLR	0.0	0.0	1.800		1	2	0.90	1.00				
77	1.4.1	CREW E	KG,KG	1071.00	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00

	1.4.6	SUPT SOFTWARE	DLR		4.000	0.0	0.0		1	2	0.90	1.00						
	1.5.1.1	PLANNING	DLR		2.700	0.0	0.400		1	2	0.90	1.00						
	1.5.1.2	PRE-LAUNCH	DLR		4.500	0.0	0.500		1	2	0.90	1.00						
	1.5.2.1	PLANNING	DLR		2.400	0.0	0.600		1	2	0.90	1.00						
	1.5.2.2	MISSION	DLR		0.0	0.0	0.600		1	2	0.90	1.00						
	1.5.3.1	PLANNING	DLR		1.500	0.0	0.020		1	2	0.90	1.00						
	1.5.3.2	TURNAROUND	DLR		0.0	0.0	1.800		1	2	0.90	1.00						
	1.6.1	CRADLE	RG,NG		1031.00	0.0	0.0	0.0	1	2	0.90	1.00	1.00	1.00	1.00	1.00		
	1.6.4	TUNNEL	DLR		0.300	0.0	0.0		1	2	0.90	1.00						
	1.6.6	EXPENDABLES	DLR		0.002	0.0	0.002		1	2	0.90	1.00						
	1.7.1	STS FLIGHTS	DL	N	0.0	0.0	1.00	0.0	1	2	0.90	0.0	1.00	1.00	1.00	1.00		
	1.7.1	STS FLIGHTS	DLR		0.0	0.0	84.100		1	2	0.90	0.0						
81	1.7.3	SYS FLIGHT TEST	DLR		84.100	0.0	0.0		1	2	0.90	1.00						

****** NOTES ON SPACE MODEL OUTPUT ******

FIRST UNIT COST IS TOTAL PER QUANTITY SPECIFIED (SEE PFU QUANTITY INPUT COLUMN)
PRODUCTION COST IS TOTAL FOR THE PRODUCTION QUANTITY SPECIFIED (SEE TOTAL QUANTITY INPUT COLUMN)
G&A INCLUDED,PROFIT EXCLUDED

M-1M

LCC OUTPUT BY PROGRAM PHASE (MILLIONS OF 1984 CONSTANT DOLLARS)

		DDT&E				PRODUCTION				OPERATIONS			
WBS	COST ELEMENT	ENG DES AND DEV	GRD TEST HDWR	TOTAL	FIRST UNIT	VEHICLE PROD	INITIAL SPARES	TOTAL	OPER	OPER SPARES	TOTAL	TOTAL
1.0	AOTV PROGRAM	1045.45	130.01	1175.46	194.14	349.45	13.00	362.45	89.86	0.0	89.86	1627.76
1.1	PROJ MGMT	20.50	0.0	20.50	3.81	6.85	0.0	6.85	0.06	0.0	0.06	27.41
1.2	S E & I	58.83	0.0	58.83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.83
1.3	SPACE VEHICLE	666.70	130.01	796.70	159.13	286.43	13.00	299.43	1.78	0.0	1.78	1097.92
1.3.1	CREW MODULE	221.01	61.80	282.81	75.65	136.16	6.18	142.34	0.0	0.0	0.0	425.16
1.3.1.1	STRUC-ENV PROT	60.66	5.71	66.38	5.71	10.28	0.57	10.85	0.0	0.0	0.0	77.23
1.3.1.3	MECHANISMS	33.43	14.02	47.44	14.02	25.23	1.40	26.63	0.0	0.0	0.0	74.07
1.3.1.3.1	MANIPULATOR	0.0	10.16	10.16	10.16	18.28	1.02	19.30	0.0	0.0	0.0	29.46
1.3.1.3.2	GRAPPLER	0.0	0.51	0.51	0.51	0.91	0.05	0.96	0.0	0.0	0.0	1.47
1.3.1.3.3	OTHER MECHANISMS	33.43	3.35	36.78	3.35	6.03	0.34	6.37	0.0	0.0	0.0	43.15
1.3.1.4	EPS	0.0	0.73	0.73	0.73	1.31	0.07	1.39	0.0	0.0	0.0	2.12
1.3.1.4.2	CONV/DISTR	0.0	0.73	0.73	0.73	1.31	0.07	1.39	0.0	0.0	0.0	2.12
1.3.1.6	COMM/DATA HDL	3.97	2.97	6.94	2.97	5.34	0.30	5.64	0.0	0.0	0.0	12.58
1.3.1.7	CONT/DISPLAYS	16.01	12.09	28.10	12.09	21.77	1.21	22.98	0.0	0.0	0.0	51.08
1.3.1.8	ECLS	33.06	15.75	48.81	15.75	28.35	1.58	29.93	0.0	0.0	0.0	78.73
1.3.1.9	CREW ACCOMMOD.	17.57	10.53	28.10	10.53	18.96	1.05	20.01	0.0	0.0	0.0	48.12
1.3.1.10	O/B SOFTWARE	28.30	0.0	28.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.30
1.3.1.11	SYS TST & EVAL	5.79	0.0	5.79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.79
1.3.1.12	INSTL,ASSY,C/O	0.0	0.0	0.0	12.36	22.25	0.0	22.25	0.0	0.0	0.0	22.25
1.3.1.13	S E & I	17.89	0.0	17.89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.89
1.3.1.14	PROJ MGMT	4.33	0.0	4.33	1.48	2.67	0.0	2.67	0.0	0.0	0.0	7.00
1.3.2	VEHICLE MODULE	439.05	66.87	505.92	81.84	147.32	6.69	154.01	0.10	0.0	0.10	660.02
1.3.2.1	AEROSHELL SYS	1.44	12.47	13.90	12.47	22.44	1.25	23.69	0.08	0.0	0.08	37.67
1.3.2.2	PROPULSION SYS	3.45	3.69	7.14	3.69	6.65	0.37	7.02	0.0	0.0	0.0	14.16
1.3.2.2.1	ENGINE	0.0	3.44	3.44	3.44	6.19	0.34	6.54	0.0	0.0	0.0	9.98
1.3.2.2.2	FUEL SYS	2.73	0.14	2.87	0.14	0.24	0.01	0.26	0.0	0.0	0.0	3.12

1.3.1.7	CONT/DISPLAYS	16.01	12.09	28.10	12.09	21.77	1.21	22.98	0.0	0.0	0.0	51.08
1.3.1.8	ECLS	33.06	15.75	48.81	15.75	28.35	1.58	29.93	0.0	0.0	0.0	78.73
1.3.1.9	CREW ACCOMMOD.	17.57	10.53	28.10	10.53	18.96	1.05	20.01	0.0	0.0	0.0	48.12
1.3.1.10	O/B SOFTWARE	28.30	0.0	28.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.30
1.3.1.11	SYS TST & EVAL	5.79	0.0	5.79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.79
1.3.1.12	INSTL,ASSY,C/O	0.0	0.0	0.0	12.36	22.25	0.0	22.25	0.0	0.0	0.0	22.25
1.3.1.13	S E & I	17.89	0.0	17.89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.89
1.3.1.14	PROJ MGMT	4.33	0.0	4.33	1.48	2.67	0.0	2.67	0.0	0.0	0.0	7.00
1.3.2	VEHICLE MODULE	439.05	66.87	505.92	81.84	147.32	6.69	154.01	0.10	0.0	0.10	660.02
1.3.2.1	AEROSHELL SYS	1.44	12.47	13.90	12.47	22.44	1.25	23.69	0.08	0.0	0.08	37.67
1.3.2.2	PROPULSION SYS	3.45	3.69	7.14	3.69	6.65	0.37	7.02	0.0	0.0	0.0	14.16
1.3.2.2.1	ENGINE	0.0	3.44	3.44	3.44	6.19	0.34	6.54	0.0	0.0	0.0	9.98
1.3.2.2.2	FUEL SYS	2.73	0.14	2.87	0.14	0.24	0.01	0.26	0.0	0.0	0.0	3.12
1.3.2.2.4	TANK INSUL	0.72	0.12	0.84	0.12	0.21	0.01	0.22	0.0	0.0	0.0	1.06
1.3.2.3	PAYLOAD SYS	30.74	2.23	32.97	2.23	4.01	0.22	4.23	0.0	0.0	0.0	37.20
1.3.2.4	ACPS	4.24	3.34	7.58	3.34	6.01	0.33	6.35	0.0	0.0	0.0	13.92
1.3.2.5	G N & C	94.74	22.93	117.68	22.93	41.28	2.29	43.58	0.0	0.0	0.0	161.25
1.3.2.6	STRUCTURE	103.01	11.06	114.07	11.06	19.91	1.11	21.02	0.02	0.0	0.02	135.11
1.3.2.6.1	SHELL	47.36	5.32	52.68	5.32	9.57	0.53	10.10	0.0	0.0	0.0	62.78
1.3.2.6.2	SUPPORT	50.33	4.49	54.82	4.49	8.09	0.45	8.54	0.0	0.0	0.0	63.36
1.3.2.6.3	FUEL TANK	0.79	0.35	1.14	0.35	0.64	0.04	0.67	0.01	0.0	0.01	1.83
1.3.2.6.4	OXIDIZER TANK	4.53	0.90	5.43	0.90	1.62	0.09	1.70	0.01	0.0	0.01	7.14
1.3.2.7	MECHANISMS	119.46	7.42	126.88	7.42	13.36	0.74	14.10	0.0	0.0	0.0	140.98
1.3.2.7.1	BERTHING	35.96	2.31	38.27	2.31	4.16	0.23	4.39	0.0	0.0	0.0	42.66
1.3.2.7.2	FLAPS	50.07	3.53	53.60	3.53	6.35	0.35	6.70	0.0	0.0	0.0	60.30
1.3.2.7.3	OTHER	33.43	1.58	35.01	1.58	2.85	0.16	3.01	0.0	0.0	0.0	38.02
1.3.2.8	EPS	4.54	0.95	5.49	0.95	1.71	0.10	1.81	0.0	0.0	0.0	7.30
1.3.2.8.3	CONV/DISTR	4.54	0.95	5.49	0.95	1.71	0.10	1.81	0.0	0.0	0.0	7.30
1.3.2.9	INSTRUMENTATION	20.25	1.61	21.85	1.61	2.89	0.16	3.05	0.0	0.0	0.0	24.91
1.3.2.10	COMM/DATA HDL	1.55	1.16	2.71	1.16	2.09	0.12	2.20	0.0	0.0	0.0	4.92
1.3.2.13	SYS TST & EVAL	11.50	0.0	11.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.50
1.3.2.14	INSTL,ASSY,C/O	0.0	0.0	0.0	13.37	24.07	0.0	24.07	0.0	0.0	0.0	24.07
1.3.2.15	S E & I	35.54	0.0	35.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.54
1.3.2.16	PROJ MGMT	8.61	0.0	8.61	1.60	2.89	0.0	2.89	0.00	0.0	0.00	11.50
1.3.3	DROP TANK	6.58	1.34	7.92	1.64	2.95	0.13	3.09	1.62	0.0	1.62	12.63
1.3.3.1	STRUCTURE	5.75	1.21	6.96	1.21	2.18	0.12	2.30	1.21	0.0	1.21	10.46
1.3.3.2	INSULATION	0.0	0.13	0.13	0.13	0.24	0.01	0.25	0.13	0.0	0.13	0.51
1.3.3.6	SYS TST & EVAL	0.17	0.0	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.17
1.3.3.7	INSTL,ASSY,C/O	0.0	0.0	0.0	0.27	0.48	0.0	0.48	0.27	0.0	0.27	0.75
1.3.3.8	S E & I	0.53	0.0	0.53	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.53
1.3.3.9	PROJ MGMT	0.13	0.0	0.13	0.03	0.06	0.0	0.06	0.02	0.0	0.02	0.20
1.3.4	CONSUMABLES	0.05	0.0	0.05	0.0	0.0	0.0	0.0	0.05	0.0	0.05	0.11
1.3.4.1	FUEL	0.05	0.0	0.05	0.0	0.0	0.0	0.0	0.05	0.0	0.05	0.10
1.3.4.3	CREW PROV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.00
1.4	GND SPPT SYS	104.86	0.0	104.86	0.0	0.0	0.0	0.0	0.0	0.0	0.0	104.86
1.4.2	TRAINERS/SIMUL	24.15	0.0	24.15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.15
1.4.3	LOGISTICS	0.50	0.0	0.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.50
1.4.4	LAUNCH SPPT	0.40	0.0	0.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.40
1.4.5	GSE	65.03	0.0	65.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.03
1.4.5.1	CREW MODULE	21.67	0.0	21.67	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.67

1.3.2.15	S E & I	35.54	0.0	35.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.54
1.3.2.16	PROJ MGMT	8.61	0.0	8.61	1.60	2.89	0.0	2.89	0.00	0.0	0.00	11.50
1.3.3	DROP TANK	6.58	1.34	7.92	1.64	2.95	0.13	3.09	1.62	0.0	1.62	12.63
1.3.3.1	STRUCTURE	5.75	1.21	6.96	1.21	2.18	0.12	2.30	1.21	0.0	1.21	10.46
1.3.3.2	INSULATION	0.0	0.13	0.13	0.13	0.24	0.01	0.25	0.13	0.0	0.13	0.51
1.3.3.6	SYS TST & EVAL	0.17	0.0	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.17
1.3.3.7	INSTL,ASSY,C/O	0.0	0.0	0.0	0.27	0.48	0.0	0.48	0.27	0.0	0.27	0.75
1.3.3.8	S E & I	0.53	0.0	0.53	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.53
1.3.3.9	PROJ MGMT	0.13	0.0	0.13	0.03	0.06	0.0	0.06	0.02	0.0	0.02	0.20
1.3.4	CONSUMABLES	0.05	0.0	0.05	0.0	0.0	0.0	0.0	0.05	0.0	0.05	0.11
1.3.4.1	FUEL	0.05	0.0	0.05	0.0	0.0	0.0	0.0	0.05	0.0	0.05	0.10
1.3.4.3	CREW PROV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.00
1.4	GND SPPT SYS	104.86	0.0	104.86	0.0	0.0	0.0	0.0	0.0	0.0	0.0	104.86
1.4.2	TRAINERS/SIMUL	24.15	0.0	24.15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.15
1.4.3	LOGISTICS	0.50	0.0	0.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.50
1.4.4	LAUNCH SPPT	0.40	0.0	0.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.40
1.4.5	GSE	65.03	0.0	65.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.03
1.4.5.1	CREW MODULE	21.67	0.0	21.67	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.67
1.4.5.2	VEHICLE MODULE	43.04	0.0	43.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.04
1.4.5.3	DROP TANK	0.32	0.0	0.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.32
1.4.6	SUPT SOFTWARE	4.00	0.0	4.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.00
1.4.7	TRAINING	10.78	0.0	10.78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.78
1.5	MISSION OPS	11.10	0.0	11.10	0.0	0.0	0.0	0.0	3.92	0.0	3.92	15.02
1.5.1	PRE-LAUNCH OPS	7.20	0.0	7.20	0.0	0.0	0.0	0.0	0.90	0.0	0.90	8.10
1.5.1.1	PLANNING	2.70	0.0	2.70	0.0	0.0	0.0	0.0	0.40	0.0	0.40	3.10
1.5.1.2	PRE-LAUNCH	4.50	0.0	4.50	0.0	0.0	0.0	0.0	0.50	0.0	0.50	5.00
1.5.2	MISSIONS OPS	2.40	0.0	2.40	0.0	0.0	0.0	0.0	1.20	0.0	1.20	3.60
1.5.2.1	PLANNING	2.40	0.0	2.40	0.0	0.0	0.0	0.0	0.60	0.0	0.60	3.00
1.5.2.2	MISSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.60	0.0	0.60	0.60
1.5.3	TURNAROUND OPS	1.50	0.0	1.50	0.0	0.0	0.0	0.0	1.82	0.0	1.82	3.32
1.5.3.1	PLANNING	1.50	0.0	1.50	0.0	0.0	0.0	0.0	0.02	0.0	0.02	1.52
1.5.3.2	TURNAROUND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.80	0.0	1.80	1.80
1.6	FLT SPPT EQUIP	81.38	0.0	81.38	0.0	0.0	0.0	0.0	0.00	0.0	0.00	81.38
1.6.1	CRADLE	81.08	0.0	81.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.08
1.6.4	TUNNEL	0.30	0.0	0.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.30
1.6.6	EXPENDABLES	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.00
1.7	SPACE TRANSPORT	84.10	0.0	84.10	0.0	0.0	0.0	0.0	84.10	0.0	84.10	168.20
1.7.1	STS FLIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.10	0.0	84.10	84.10
1.7.3	SYS FLIGHT TEST	84.10	0.0	84.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.10
1.8	INSTL,ASSY,C/O	0.0	0.0	0.0	31.20	56.16	0.0	56.16	0.0	0.0	0.0	56.16
1.9	SYS TST & EVAL	17.99	0.0	17.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.99